

BUREAU OF MINES AUTHORIZATION AND OVERSIGHT

HEARING

BEFORE THE
SUBCOMMITTEE ON TRANSPORTATION,
AVIATION AND MATERIALS
OF THE
COMMITTEE ON
SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
NINETY-NINTH CONGRESS
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BUREAU OF MINES AUTHORIZATION AND OVERSIGHT

WEDNESDAY, APRIL 24, 1985

HOUSE OF REPRESENTATIVES, COMMITTEE ON SCIENCE AND
TECHNOLOGY, SUBCOMMITTEE ON TRANSPORTATION,
AVIATION AND MATERIALS,

Washington, DC.

The subcommittee met, pursuant to notice, at 9:38 a.m., in room 2325, Rayburn House Office Building, Hon. Harry M. Reid presiding.

Present: Representatives Reid, Lewis, and Packard.

Staff present: Paul C. Maxwell, science consultant, and Harriet Smith, technical consultant.

Mr. REID. This meeting of the Science and Technology Committee will come to order. I certainly appreciate the opportunity of being here. We would like to excuse the chairman of the subcommittee, Dan Glickman, who is involved in an Agricultural Committee meeting this morning which is very important to him in his district. He wanted me to express to the witnesses his apologies for not being able to be here this morning.

We're here this morning to hear testimony from a number of witnesses regarding proposed funding levels for the Bureau of Mines for fiscal year 1986. I'm particularly pleased to be able to chair this hearing; having been raised in a mining town myself, I feel more familiar with the topic today than many of the topics we discuss.

Because I am eager to hear what the panelists have to say, my opening statement this morning will be quite brief. Let me say at the outset that I am fully supportive of efforts to bring Government spending in harmony with revenues. It is no secret that the budget deficit this year will eclipse the \$200 billion level, while the overall Federal debt makes the \$1 trillion mark seem like a memory.

In the midst of these cost containment pressures, the administration has done an admirable job, in some cases, in submitting budget requests to Congress that reconcile these pressures with the need to adequately maintain funding levels for Federal programs. Unfortunately, this is not one of those cases.

Clearly, Mr. Horton, you're in a difficult position and I can empathize with that. As Director of the Bureau of Mines, you preside over an agency whose funding the administration is recommending to be trimmed by some 30 percent. This, while the whole Depart-

ment of the Interior, of which your Bureau is a part, is to be cut only 14 percent.

While I know that in public you must echo the administration line that \$104 million will be sufficient, I'm confident that in your heart you feel differently.

Why is there such a huge discrepancy. If we were to adopt the administration request for the Bureau of Mines, which is unlikely, its budget will have been reduced by over \$50 million in just 2 years. If this continues, in 2 more years the Bureau will be gone.

I took note of the request to eliminate the entire Minerals Institute Program. I took note of the request to slice moneys available for minerals research activities by about 30 percent. More specifically, the Minerals and Materials Research Program is to be cut by almost \$10 million. This worries me. I'm especially worried because of the role that strategic minerals play in our national defense. Fully aware that the United States derives a large percentage of strategic minerals from countries currently under less than stable political conditions, I'd like to make sure that our technology in this area is advanced enough to allow us to recover the minerals that we do have from our own resources as efficiently as possible, if need be the case.

Again, I look forward to the testimony from all our panelists and hope that by the end of the hearing we can reach some sort of consensus on funding for the Bureau of Mines next year.

My colleague and ranking member, Mr. Lewis, has a statement.

Mr. LEWIS. Thank you, Mr. Chairman. The Bureau of Mines budget request for fiscal year 1986 is a small part of the overall budget and certainly research directed toward enhancing domestic availability of strategic and critical materials is a worthwhile activity.

However, both Congress and the administration have made it clear that reducing budget deficits has a very high priority this year. The Science and Technology Committee has already seen three of its authorization bills scaled back to 1985 levels. Therefore, it is especially important today for us to ensure that our scarce R&D dollars are allocated where they can do the most good.

I welcome the opportunity to learn more about the activities of the Bureau of Mines. I am interested in seeing how effective these programs are and how they fit in with other materials research. I am confident that the expert witnesses who are assembled here today will be able to enlighten us and I join you, Mr. Chairman, in welcoming them here this morning.

Mr. REID. Thank you very much, Mr. Lewis. For the record, I would introduce and make a part of the record the opening statement of Subcommittee Chairman Dan Glickman.

Without objection, that is the order.

[The prepared opening statement of Mr. Glickman follows:]

OPENING STATEMENT

HONORABLE DAN GLICKMAN, CHAIRMAN
SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS
COMMITTEE ON SCIENCE AND TECHNOLOGY

AUTHORIZATION AND OVERSIGHT
OF THE
BUREAU OF MINES FOR FY 1986

APRIL 24, 1985

WE ARE CONDUCTING TODAY'S HEARING TO CONSIDER THE BUDGET REQUEST OF THE BUREAU OF MINES FOR FY 1986. I WOULD LIKE TO NOTE THAT THIS HEARING IS IN KEEPING WITH THE COMMITTEE'S SCIENCE AND TECHNOLOGY OVERSIGHT RESPONSIBILITIES IN GENERAL, AND OUR SUBCOMMITTEE'S MATERIALS RESPONSIBILITIES SPECIFICALLY.

THE BUREAU OF MINES, WHILE A RELATIVELY SMALL ORGANIZATION WITHIN THE DEPARTMENT OF INTERIOR, CONDUCTS IMPORTANT, IF NOT CRITICAL, ACTIVITIES TO HELP SUPPORT OUR NATION'S MINING AND MINERALS INDUSTRIES. GIVEN THIS IMPORTANCE, THE SUBCOMMITTEE IS ESPECIALLY CONCERNED WITH THE PRESIDENT'S OVERALL REQUEST FOR THE BUREAU OF ONLY \$104.3 MILLION IN FY 1986, A REDUCTION OF OVER \$40 MILLION OR 27.5% FROM THE FY 1985 LEVELS. MORE PARTICULARLY, THE REQUEST REDUCES THE MINERALS AND MATERIALS RESEARCH LINE BY 28.4%, WHILE ELIMINATING THE MINERAL INSTITUTE PROGRAM ENTIRELY. THIS CONTRASTS WITH A REDUCTION OF ONLY 1.8% IN THE DEPARTMENT OF INTERIOR'S OVERALL BUDGET REQUEST FOR FY 1986.

IT APPEARS PUZZLING THAT THESE SEVERE REDUCTIONS COME AT A TIME WHEN THE MINING AND METALLIC MINERALS INDUSTRIES ARE FACING HARSH TESTS OF SURVIVABILITY IN THIS APPARENTLY RECOVERY-PROOF SEGMENT OF THE ECONOMY. AS POIGNANTLY SHOWN IN LAST DECEMBER'S NEWSWEEK COVER STORY, "THE DEATH OF MINING", WE ARE WATCHING THE REDUCTION OF A \$9.0 BILLION ENTERPRISE IN 1980 TO ONE OF LESS THAN \$5.9 BILLION IN 1984. MINING EMPLOYMENT, DOWN OVER 60,000 SINCE 1981, COULD FALL AN ADDITIONAL 20,000 IN THE NEXT FEW YEARS. SOME BELIEVE THAT REVERSAL OF THESE TRENDS MAY ONLY BE FOUND BY ENHANCING OUR MINING PRODUCTIVITY THROUGH CONTINUING APPLICATIONS OF IMPROVED TECHNOLOGY, AS WELL AS CHANGES IN CURRENT FEDERAL POLICY REGARDING TRADE AND THE ENVIRONMENT.

EQUALLY PUZZLING IS THE TURN-ABOUT FROM THESE PROGRAMS, EMBRACED BY THE ADMINISTRATION ONLY A SHORT TIME AGO. IN RESPONSE TO THE NATIONAL MATERIALS AND MINERALS POLICY, RESEARCH AND DEVELOPMENT ACT OF 1980 (P.L. 96-479), THE SECRETARY OF INTERIOR SENT THIS SUBCOMMITTEE A COPY OF THE REPORT REQUIRED BY THAT LAW RELATING TO MINING AND MINERALS RESEARCH. NOTING THAT THE BUREAU HAS PRINCIPAL RESPONSIBILITY FOR CONDUCTING MINERALS RESEARCH, THE REPORT POINTED TO SIGNIFICANT INCREASES IN MINERALS AND MATERIALS RESEARCH DURING FY 1981 THROUGH FY 1984 DESIGNED TO ENHANCE MINERALS INDUSTRY'S PRODUCTIVITY, AND TO STRENGTHEN SUBSTITUTION, RECYCLING AND RECOVERY OF STRATEGIC AND CRITICAL MINERALS. THE CURRENT REQUEST SEVERELY UNDERCUTS THAT SUPPORT.

TODAY WE WILL BE HEARING FROM THE DIRECTOR OF THE BUREAU, MR. ROBERT HORTON, WHO WILL HOPEFULLY EXPLAIN SOME OF THESE INCONSISTENCIES. I SHOULD STATE AT THIS POINT THAT I RECOGNIZE THAT THESE REDUCTIONS MAY NOT BE ENTIRELY IN LINE WITH MR. HORTON'S PERSONAL PREFERENCES, BUT HE IS RESPONSIBLE FOR REPRESENTING THE ADMINISTRATION'S POSITION REGARDING THE BUREAU. WE WILL ALSO BE HEARING FROM A NUMBER OF OUTSIDE WITNESSES WHO WILL TESTIFY ON THESE MATTERS.

Mr. REID. The first witness this morning is Mr. Robert Horton, Director of the Bureau of Mines. Mr. Horton, we appreciate your presence. We have your written statement. We would ask that you summarize that so that we will have ample time to ask questions.

STATEMENT OF ROBERT C. HORTON, DIRECTOR, BUREAU OF MINES, U.S. DEPARTMENT OF THE INTERIOR, WASHINGTON, DC

Mr. HORTON. Thank you, Mr. Chairman. It's a special privilege today to appear before a fellow Nevadan, and one also born in a mining camp. Las Vegas and Reno weren't so important in those days.

I've asked, as you have indicated, that my formal testimony be submitted.

Mr. REID. We will make that part of the record. That is the order.

Mr. HORTON. I would like to spend just a few minutes briefly detailing the activities of the Bureau of Mines. If I may, I'll use these charts.

Mr. REID. Mr. Horton, could you use the microphone? The reporter here can't get that. You're just going to have to hold that. I've just gained a friend here this morning in the reporter.

Mr. HORTON. The Bureau of Mines has a rather simple organization headed by a Director. We have two Assistant Directors, one for management resources and one for management services, who handle much of the paperwork and support activities which are common to most Federal agencies.

Then, five Assistant Directors who handle the principal activities of the Bureau of Mines. Those activities can be divided rather rapidly into three areas: information, research, and helium operations.

We have an Assistant Director for minerals information who is responsible for the collection of mineral production data and consumption data throughout the world. We put out about 70,000 canvass forms each year for domestic producers and determine the production from 170 foreign countries.

The Assistant Director of Mineral Data Analysis is responsible for using that data to assess the position of the United States vis-a-vis the rest of the world to support requests from Congress and the administration that require particular studies on individual minerals or mineral problems.

The Assistant Director for Mining Research is responsible for our health and safety research and our mining technology research.

The Assistant Director of Minerals and Materials Research is responsible for our research in extractive metallurgy and in our materials and recycling technology, of which you are most interested.

The helium operation is commonly overlooked but the Bureau of Mines operates the Government's Helium Conservation Program. We have some 35 billion cubic feet of helium in storage and we supply helium to all Federal agencies. As I look around the room at the splendid pictures of spacecraft, these spacecraft are up there, in small part, because of the Bureau of Mines. One of our major customers is NASA. We take pride in the fact that nothing has ever been delayed in NASA's activity for failure of the Bureau of Mines to deliver helium.

The Bureau of Mines role in the mineral cycle has a certain responsibility. On the left of this chart is the Geological Survey, which is responsible for geologic definition, geologic mapping, general reconnaissance, and for exploration, in a sense. They don't do direct mineral exploration but if one were to compare this to a mining company, they would be on the exploration side.

The Bureau of Mines, then, is responsible for determining factors affecting resource development, the mining beneficiation, processing, refining, and materials. It also has a high responsibility in recycling and reuse where Commerce, Labor, and Defense and the others are concerned with the consumption end, design, fabrication, manufacturing, and use.

[The prepared statement of Mr. Horton follows:]

Testimony of Mr. Robert C. Horton
 Director, Bureau of Mines
 Department of the Interior
 Before the
 House of Representatives
 Committee on Science and Technology
 Subcommittee on Transportation, Aviation and Materials
 April 24, 1985

Good morning Mr. Chairman and Subcommittee Members. Thank you for the opportunity to testify before you concerning Bureau of Mines activities.

Under organic legislation such as that establishing the Bureau of Mines, and Executive Orders under the Defense Production and Stock Piling Acts, the Department of the Interior (DOI) is responsible for emergency readiness plans and programs for all nonfuel raw materials. DOI has chartered the Emergency Minerals Administration to carry out actual operations in the event of a major emergency, and the Bureau of Mines acts in the capacity of the lead agency with support as needed from the U.S. Geological Survey (USGS) and other Interior units. In emergencies, DOI operates under the direction of the Federal Emergency Management Agency (FEMA).

The Bureau of Mines works on a daily basis with FEMA in the formulation and testing of defense readiness measures and in the development and execution of stockpile policies and programs. The Bureau of Mines also works on a day-to-day basis with senior echelons of the National Security Council and the Department of Defense (DOD), including the Joint Chiefs of Staff, the Under Secretary for Research and Engineering, the Legislative Counsel, military educational institutions, including the National Defense University, the Industrial College of the Armed Forces, the service colleges and academies of the services, and major field installations such as the Joint Aeronautical Materials Activity at Wright-Patterson Air Force Base, the State Department, the Central Intelligence Agency, the Agency for International Development, and various bureaus of the Canadian Government in developing defense measures. Further, the Bureau works directly with various levels of the North Atlantic Treaty Organization (NATO).

As a result of our continual monitoring of mineral supply and demand and our technological competence, the Bureau of Mines has the framework needed to discharge priorities, allocations, and supply expansion responsibilities. The Bureau would also act as the claimant agency for the mineral sector of the economy to assure needed fuel, power, transportation, personnel, supplies, and equipment in the event of an emergency. In 1975, the Bureau organized nearly 100 interagency mineral commodity committees. These committees include experts from the Bureau of Mines, USGS, and one or more areas of the Departments of State, Commerce, Defense, the CIA, the General Services Administration, Treasury, U.S. Trade Representatives, the Council of Economic Advisors, the International Trade Commission, the Commodity Futures Trading Commission, FEMA, and for certain commodities, the Departments of Agriculture, Energy, and Transportation. These committees would be promptly called upon in the event of minor or major emergencies in order to formulate coordinated government actions.

Since World War I the Bureau of Mines has supported these activities with research programs focusing on national security. One of our first projects was the application of helium for use in barrage and observation balloons. In World War II and the Korean War the Bureau's scientific staff developed two new metals, titanium and zirconium, and synthetic fuels from coal.

This Minerals and Materials Research program now provides fundamental scientific and technical information essential to accelerate technological advances in the Nation's nonfuel minerals industry. The program emphasizes basic studies designed to determine new fundamental scientific concepts in extractive metallurgy, materials, and recycling technologies. Such work also provides the on-the-shelf technology that could be used in times of national emergency to treat otherwise uneconomic domestic resources, thereby helping to offset shortfalls in supply caused by the cutoff of foreign sources.

Concern over the Nation's dependence on foreign sources for many strategic and critical minerals and raw materials continues to be a preeminent criterion for allocating resources to minerals research networks. For strategic and critical minerals there are three principal research-oriented approaches to addressing this national problem: (1) devise new extractive metallurgy methods for treating domestic low-grade and complex resources; (2) seek substitute and alternative materials; and (3) reduce imports through conservation and recycling. The Minerals and Materials Research program actively pursues all three approaches with the long-term, fundamental high-risk research necessary to provide technological solutions.

Most of the minerals and materials research is conducted at six research centers located at Albany, Oregon; Avondale, Maryland; Reno, Nevada; Rolla, Missouri; Salt Lake City, Utah; and Tuscaloosa, Alabama. These centers are located on or close to major universities excelling in the mineral sciences. We maintain an active association with these universities.

The Bureau continually seeks to promote industrial adoption of the technology resulting from its research. The transfer of this technology is formally presented to the national and international scientific communities through Bureau technical publications and papers presented at scientific meetings which are usually published in the technical and trade press. The same objective is pursued informally, as a concomitant of Bureau research activities, by its technical personnel in the field as part of their routine contacts with their counterparts in other research organizations in the public and private sectors, and as part of a continuing and close working relationship with operating personnel in the mineral industries.

Currently, Minerals and Materials Research has 52 cooperative agreements with industry, professional associations, and other Federal agencies. These joint activities range in content from simple exchange of technical information to joint planning of research to actual testing in mineral processing plants.

The Bureau also administers the Mineral Institutes Program. This program was initiated to provide seed money to encourage the development of mineral-related graduate programs at selected state colleges and universities. Under this program, 31 designated State mineral institutes at research-oriented schools of higher learning, receive matching allotment grants. These institutes use the program for such activities as aiding undergraduate, graduate, and postdoctoral students in obtaining degrees in mineral-related fields, sponsoring continuing education courses, supporting research initiation projects, arranging for visiting professors and improvement of laboratories. In addition, research grants are made to five generic mineral technology centers located at selected mineral institutes in support of research of broad applicability to the minerals industry. These generic centers deal with such research areas as mine systems design and ground control, comminution, mineral industry waste treatment and recovery, pyrometallurgy, and respirable dust.

The Bureau has a Minerals Information directorate which performs the data collection and dissemination functions by continuously monitoring domestic production, imports, exports, stocks, and consumption of all major nonfuel minerals. Detailed reports are received monthly, quarterly, and/or annually from domestic mines, smelters, refineries, recyclers, and major users. The Bureau administers 169 separate questionnaires canvassing some 50,000 establishments. Monthly import and export data are obtained from the U.S. Customs Service via the Bureau of the Census of the Department of Commerce.

Data collection and dissemination is supported by the Automated Mineral Information System (AMIS) which processes the data gathered in Bureau canvasses of the minerals industry and by other Minerals Information Systems activities that set uniform standards to guide data collection, document the procedures, and improve the statistical methodologies for data collection. Mineral supply and demand data is utilized in conducting studies and analyses as a basis for minerals policy assessment and development and for land assessment decisions. Information on minerals supply and demand is also used in guiding and prioritizing Bureau research.

To keep this information current and complete, commodity and foreign country specialists coordinate their work with numerous Federal agencies, Foreign government organizations, and international organizations. Commodity and Foreign Country Specialists analyze information to identify trends, provide early warning of problems, and forecast future U.S. and world supply and demand for the nonfuel minerals and their impact on the domestic minerals industry.

Minerals information is disseminated through special studies, meetings, by personal contact, and by publications such as the Minerals Yearbook, Mineral Facts and Problems, the "Mineral Industry Surveys," which give up-to-date detailed statistics, and for several major important mineral materials bimonthly data is also summarized in the Bureau's "Minerals and Materials Bimonthly Survey." A detailed review of U.S. and world production

for more than 100 commodities is provided in the annual "Mineral Commodity Summaries," and special mineral commodity profiles giving details of world production, technology, reserves, resources, and outlook to the year 2000 are published as appropriate.

Our Mineral Data Analysis activities involve basic technical and economic analyses of mineral issues, problems, and policies relating to dependable supplies of minerals in adequate quantities and at acceptable prices. World-wide consumption patterns are constantly changing both in quantity and variety of minerals as well as in sources of supply. These changes have a comparatively greater impact upon the United States than upon other nations. One reason is that on a per-capita basis we consume a disproportionate share of the total world mineral supply, and will doubtless continue to do so.

We obtain factual and analytical information by supplementing the Bureau's developed mineral commodity data base with data from engineering and economic investigations of domestic and foreign mineral resources and from assessments of the mineral potential of U.S. public lands. Approximately 2,400 of the world's major nonfuel mineral deposits have been evaluated and are used as a basis for various studies ranging from data printouts of geological and engineering information to discounted cash flow analyses of individual mining operations and commodity availability analyses. This work supports analysis of national and international problems and Government policies that affect mineral supply and demand.

The Bureau also conducts mining research work to address the problems of three interacting elements--the miner, the miner's workplace, and mining equipment. This research is conducted at four research centers located at Pittsburgh, Pennsylvania, Twin Cities, Minnesota, Spokane, Washington and Denver, Colorado. Bureau health and safety research contributes technology to improve the working conditions of miners and other workers in the mineral industry. Solutions to many immediate problems have been developed and adopted by the mining and minerals industries. Additional efforts on long-term research dedicated to increasing the fundamental knowledge necessary for optimum health and safety continue to be required. The evolution of the Bureau's program toward more basic research will continue in FY 1986 with emphasis on respirable dust, industrial hazards, fires and explosions, and ground control problems. Health and safety problems identified by the Mine Safety and Health Administration (MSHA) that require immediate attention will also be addressed.

Bureau mining research is closely coordinated with MSHA, the National Institute for Occupational Safety and Health, other Federal agencies, States, the mining and mineral industries, and foreign mining research organizations. The total program is reviewed by MSHA and research priorities are jointly established. Mining companies and equipment manufacturers participate in the program through technology transfer seminars and cooperative projects, and are informed of significant accomplishments by briefings, Departmental news releases, and other publications.

I have attached to my statement, for the record, further details on the programs I have touched on. I would be pleased to answer any questions you may have at this time.

4 Attachments

EXTRACTIVE METALLURGY TECHNOLOGY

Extractive metallurgy research is directed basic research conducted to gain a fundamental understanding of the physical and chemical processes which govern each of the steps in metal production. Problems in the recovery of mineral values from specific low-grade or complex domestic ores that have national security importance to the United States are addressed also. The research effort synthesizes and builds upon knowledge developed by the academic community in many diverse fields of science and engineering to devise new methods to separate and recover metals. In addition, generic engineering data are developed for use by the industrial community to determine technological options and to reduce the risk of investment in new technology. The Extractive Metallurgy Technology program, therefore, bridges the gap between the concepts developed by the academic community and the developmental research of the mineral industries.

Thermodynamic data developed as a continuing part of the extractive metallurgy effort is contributing significantly to the construction of alloy phase diagrams, basic information for the development of advanced superalloys.

Froth flotation is the most important separation method used by the minerals industry to separate mineral values from the waste rock. Separation depends on the relative surface chemical properties of the minerals to be separated. Using state-of-the-art surface analytical equipment based on electron and optical spectroscopies, in conjunction with electrochemical measurements, Bureau scientists have produced data on the electrochemistry of flotation that is opening the way for revolutionary technology in this area. The new technology should simplify the separation of complex ores, reduce environmental impacts, and enable maximum water recovery for recycling.

About 20 percent of our domestic cobalt requirements could be met from recovery of the byproduct cobalt from Missouri lead and zinc mining operations. However, current economic considerations and uncertainties in the basic technological approach preclude private sector efforts to recover the cobalt. We have developed the basis for technology to separate the cobalt and are presently obtaining engineering data in cooperation with a commercial producer.

Gallium and germanium are important materials for light-emitting diodes, lasers, bubble memories, fiber optic circuits, and infrared optics. Presently, the metals are obtained as byproducts from bauxite and zinc processing. Research is developing the basis for recovery of these metals from alunite, an abundant domestic resource.

Materials Technology

The Bureau's materials research addresses two related objectives. The first is to devise substitutes and/or alternatives from domestic mineral resources that can reduce the need for imported metals and minerals currently used in structural, high-temperature, and corrosion-resistant metallic and nonmetallic materials, particularly those related to mining, metallurgical, and minerals

processing equipment. The second objective is to improve the service life and performance qualities of materials through better fracture-, corrosion-, and wear-resistance characteristics. In these efforts, special attention is given to the use of abundant domestic resources to reduce foreign dependence.

In all of this research, the Bureau works closely with industry to ensure that newly developed technology is put into practice as soon as possible. To prevent overlaps and to make certain that our efforts are keyed closely to national needs, we also maintain close contact with other Federal agencies. For example, the Bureau of Mines has developed a new low-cost method for joining of aluminum with standard tin-lead solders and fluxes, which in the past was virtually impossible. The National Automotive Radiator Service Association has conducted regional workshops with Bureau of Mines technical assistance to demonstrate the new soldering method to its 15,000 members, who are mainly radiator repair shop owners. Because it is a major advance in joining technology, the new soldering system was selected for an award as one of the top 100 new technological developments in 1983 by the Industrial Research and Development Magazine Awards Committee.

Recently, we cooperated with the Department of Transportation's Federal Highway Administration to pioneer the use of synthetic ceramic aggregates such as waste slate and copper mill tailings to improve wear and skid resistance in high traffic areas such as at intersections and on- and off-ramps to freeways. Portland cement will deteriorate in a short time under salt or acidic conditions. Bureau research addressed this problem which is prevalent in the mining and minerals industry as well as in the transportation area, and resulted in a high-performance corrosion-resistant sulfur concrete. Acid and salt resistance qualities of Bureau-developed sulfur concrete placed in a zinc refinery reinforces the importance of this technology to the point where seven U.S. companies have been licensed to produce sulfur concrete.

Sulfur-extended asphalt paving technology, a related development, has been used in paving more than 200 roads during the past 10 years. Sulfur also is used to rejuvenate and recycle the oxidized asphalt in old pavements to conserve their asphalt and graded aggregate contents. The recycled paving has properties as good as new pavement.

Future advances in almost all areas of technology will require higher performance materials. Available materials are not adequate to meet the current and future high technology engineering demands. Alloy development, the materials research policy of the past, must enter the high technology age. The number of compositional changes, variations, alterations, and combinations now available to produce new alloys is limited. Moreover, many of the promising alloy compositions already have been tried, tested, and found wanting.

Modern methods of materials preparation involve the disciplines of chemical synthesis and metallurgical processing, as well as more recently developed fabrication techniques, such as rapid solidification, vapor deposition, electron beam processing, and plasma-induced oxidation. The

future lies in developing new technologies for processing existing alloys to enhance physical and chemical properties, reduce production costs, conserve critical imported materials, encourage the use of domestically-abundant raw materials, and enhance materials properties through the production of higher purity materials.

For example, materials produced by rapid solidification processing (RSP) have unique microstructures and properties, which may have a beneficial impact on the usage of strategic and critical materials. Much scientific work remains before RSP materials and their production methods are fully characterized, but they have already come into use as engineering materials and commercial production is increasing. Any significant use of RSP materials will require joining, and for many applications welding is the only acceptable method. The current Bureau of Mines program is developing the fundamental basis for joining both RSP materials and advanced ceramics to form complex shapes for engineering applications. Related Bureau research addresses the requirement for a new range of capabilities to nondestructively test advanced materials which may be more sensitive to flaws or have significantly different properties than conventional materials.

Recycling Technology

As the foremost Federal agency conducting recycling research, the Bureau's efforts are directed toward the recovery and reuse of mineral and metal values contained in a variety of wastes. Increased recovery and reuse will lead to less dependence on foreign sources for critical and strategic materials, as well as supplementing our supplies of other metals of economic importance. Environmental concerns which influence the extraction of metals and nonmetallic minerals from both primary ores and mineral-based wastes also are addressed.

The Bureau views recycling as a valuable and necessary means of conserving mineral reserves and considers the mineral-based wastes generated by industry and the consuming public as secondary reserves. Recycling, with its attendant savings in energy, is the only conservation activity that adds directly to our mineral supply. A major part of the Bureau's current program is directed toward recovering cobalt, nickel, and chromium from scrap and waste materials.

Maximum utilization of mixed scrap materials is currently impractical because of processors' inability to easily recognize and separate individual alloys. One new identification method being pursued involves quantification of spark testing. This approach is based on the correlation of spark spectra (variation of intensity measurements with wavelength of light) with alloy composition. Emphasis is on separation of superalloys, stainless steels, and chromium alloys.

Each year thousands of tons of strategic and critical metals such as cobalt, chromium, tungsten, and titanium are lost or underutilized in superalloy scrap from obsolete and worn out turbines. Normally, contaminated or unidentifiable superalloy scrap cannot be reused by superalloy producers

and must either be disposed of, exported, or used to make lower grade alloys. Because superalloys are designed to resist oxidation and dissolution, the recovery of individual critical metals from this type of scrap is technically difficult. However, resolution of this problem may be near at hand as a result of Bureau of Mines studies which have shown that the rate of metal dissolution in leach solutions can be markedly increased by first forming intermetallic compounds of superalloy scrap and either aluminum or zinc. The intermetallic compounds are brittle and can readily be broken into fine particles for rapid dissolution in acid leach solutions. Current research addresses methods to recover the individual metals from the solutions.

Worn cutting and drilling bits comprise a very high-value scrap containing cobalt and cemented carbides. The Bureau of Mines developed a simple, cheap, and efficient process using molten zinc to separate the desired components. This technology, which has been commercially adopted by seven firms, produces high-purity products with no wastes.

The Bureau has also successfully conducted research to encourage the recycling of scrapped automobiles. Although the magnetically-separated fraction of shredded automobile scrap was effectively recycled, millions of tons of nonmagnetic material were simply being landfilled. Techniques developed by the Bureau were adopted by commercial shredder installations to recover aluminum, copper, stainless steel, zinc, and plastics.

More than 90 percent of the metal supplied to secondary lead smelters, which accounts for about 45 percent of domestic production, is in the form of scrap batteries. It is not only difficult, but costly for these smelters to comply with stringent air pollution regulations for sulfur and lead emissions, and to limit lead exposure for workers. Research has resulted in the development of an economically and environmentally acceptable method to recycle the lead grids and sludge from scrap batteries as an alternative to the current smelting process. Lead of 99.99 percent purity, which can be used in maintenance-free batteries, is recovered.

MINERAL INSTITUTES PROGRAM

ACTIVITY OVERVIEW

In order to encourage State support for basic research in the mineral sciences and engineering, allotment grants, which must be matched, are made to 31 designated State mineral institutes (no more than one per State) at research-oriented schools of higher learning. In addition, research grants are made to five generic mineral technology centers located at selected mineral institutes in support of research of broad applicability to the minerals industry. Concentration of research funds to develop focal points for research, in particular mineral-related areas, was done in response to a 1982 congressional directive to consolidate the mineral institute program.

In 1984, the mineral institutes program completed its 7th and final year under the authorization provided by title III of Public Law 95-87. In August, Congress passed and the President signed Public Law 98-409, State Mining and Mineral Resources Research Institute Program, which extends the authorization for the program through FY 1989. Both Acts permit one mineral institute per State and there are currently 31 institutions eligible to receive funds as mineral institutes. The designation of a State school of higher learning as a mineral institute creates a focal point for administering funds for the various academic departments which contribute to mineral engineering research.

On July 1, 1984, as in previous years, allotment grants of \$150,000 were made to each of the 31 mineral institutes. These grants for the 1984-85 school year are made on the basis of proposals received from each institute and approved by the Bureau of Mines. In 1984, each school matched the Federal funds with \$150,000 from nonfederal sources.

Allotment Program

In 1984, 88 undergraduate, 310 graduate, and 7 postdoctoral students in various departments were aided in obtaining degrees in mineral-related fields. Nineteen continuing education courses were sponsored under this program. The allotment program also supported 236 research initiation projects. Four visiting professors were supported and instrumentation of ten laboratories improved. While the mineral institutes program does not support construction of facilities, its presence encourages States to erect appropriate facilities. During this year, construction was completed on the New Mines Building at the University of Nevada. Construction was also underway on a \$25 million complex at the University of Texas which will include a core storage facility, analytical laboratories, and research facilities. In the advanced planning stage is a \$14 million mineral laboratory at the University of Alabama and a \$4 million metallurgical facility at the University of Missouri.

Generic Center Research Program

In FY 1984, further research grants were made to each of the five generic mineral technology centers (GMTCs). By year-end, over 100 final research reports from this program had been made available to the public.

Research Projects in FY 1984

Mine Systems Design and Ground Control

- Rock Characterization in Deep Coal-Mines Ground Control
- Optimization of Pillar Dimensions in Permafrost Mines
- Improved Airflow and Climate of Underground Mines
- Ground Control Design Factors in Multiseam Mining
- Ground Control in Longwall Mining
- Diesel and Electric Cable-Reel Shuttle Car Comparison
- Alabama Coal Field Subsidence
- Access Design in Permafrost
- Underhand Longwall Cut and Fill
- Failure in Coal-Bearing Roofs
- Reinforced Timber Posts
- Underground Booster Fans
- Ground Water and Surface Structure Response
- Coal Measure Strata Caveability

Comminution

- Computer Simulation of Complex Circuits
- Large Grinding Mill Dynamics
- Phenomenological Hydrocyclone Model for Scale-Up
- Comminution of Mineral Mixtures
- Tracer Study of Rod Mill Transport
- Application of Modern Control Theory to Crushing
- Adaptive Control Strategies for Rod and Ball Mills
- Grinding Aids and Transport in Comminution
- Energy of Fragmentation and Comminution in Percussive Drilling
- Explosively Induced Shock Waves in Ore Minerals: Fracture and Attenuation
- Fluid-Flow and Particle Trajectories in Hydrocyclone Using Motion Analyzer
- Comminution of Mineral Mixtures
- Interaction of Particles During Fragmentation
- On Line Estimation of Ball/Liner Wear in Tumbling Mills
- Numerical Simulation of Comminution in Jointed Geological Media
- Semi-Autogenous Grinding

Mineral Industry Waste Treatment and Recovery

Precipitation Mechanisms of Heavy Metals
 Fluidized Bed Electrodeposition of Metal from Effluents
 Recovery of Copper and Arsenic from Electrorefining Wastes
 Tailing Fluids Waste Treatment
 Controlling Acid Mine Drainage at the Bunker Hill Mine
 Supercritical Extraction of Platinum-Group Metals
 Cyanide in Mill Tailings Impoundments
 Spatial Variability of Mill Tailings Hydraulic Properties

Pyrometallurgy

Injection of Reactants into Molten Fluids with Strongly Coupled
 Heat Transfer
 Vacuum Refining
 Mineralogy of Pyrometallurgical Feeds and Products
 Gas-Solid Reactions: Pyrophoricity
 Metal Sulfide Vaporization
 High Temperature Gas-Particle Reactions
 Behavior of Oxygen and Sulfur in Complex Mattes
 Plasma Particle Reaction Experiments
 Chromium from Low-Grade Concentrates in Transferred Arc Plasma
 Furnace
 Electrochemical Factors in Fused Salt Enhanced Reduction
 Mechanisms of Attack and Protection of Refractories

Respirable Dust

Dispersion and Transport of Respirable Dusts
 Construction of Dust Distribution Maps for Longwalls
 Fracture Mechanics of Crack Propagation in Coal
 Instrumentation of Coal Mine Dust Characterization
 Mechanism of Lung Injury of Coal Mine Dusts
 Respirable Dust Testing in Metal, Nonmetal Mines and Metallurgical
 Operations
 Modelling of Longwall Face Ventilation
 Aerodynamic Diameter Analysis of Coal Dust
 Wetting Characteristics in Relation to Dust Abatement
 One-by-One Analysis of Coal Particles Using an Automated SEM with
 X-Ray Fluorescence
 Polymorphonuclear Leukocytes in Dust Lung Interaction
 Dust-Lung Interaction in Coal Miners
 Effects of Respirable Dust on the Release of Superoxide From
 Pulmonary Alveolar Macrophages
 Magnetic Resonance of Paramagnetic Ions and Free Radicals in Coal
 Dust and in Lung Tissue Under Controlled Dust Exposure.

Secretary's Advisory Committee on Mining and Mineral Research

Both Public Law 98-409 and title III of Public Law 95-87 provide for an advisory committee, the recommendations of which are considered in the conduct of research and in the making of grants under this legislation. The Advisory Committee held one meeting in 1984 at which it reviewed the program of the Nevada Mining and Mineral Resources Research Institute and that of the Mineral Industry Waste Treatment and Recovery Generic Mineral Technology Center. The Committee approved the fiscal year 1984 allocation of funds as highly germane to the goals of the MMRRRI program and recommended some changes in the method of selecting proposals. The Committee noted the seminal work of Drs. Hibbard and Osborn, in the 1969 National Academy of Sciences study which eventually led to the establishment of the Mineral Institutes program, and voted to present them with citations for their efforts. The Committee recommended that the Secretary consider asking the National Academy to make an updated review of the need for graduate research in mineral sciences and technology. Public Law 98-409 provides for the enlargement of the Committee to 12 members; which process was underway as the year ended.

DATA COLLECTION AND DISSEMINATION

The Bureau's data collection and dissemination program is designed to maintain and provide reliable data for analyses of national minerals problems by collecting, interpreting, and disseminating worldwide information on the production, consumption and availability of nonfuel minerals. This program is implemented by mineral commodity and foreign country specialists who maintain a historical and current record of 100 mineral commodities and worldwide coverage of the minerals and related industries of 168 countries. They collect data on all aspects of the nonfuel minerals industry, from exploration and development through production, processing, and consumption. They administer 169 separate questionnaires canvassing some 50,000 establishments on a monthly, quarterly, semiannual, and/or annual basis, depending on information requirements.

Specialists, with expertise in specific mineral commodities or mineral activities at the domestic and foreign level, analyze information to identify trends, provide early warning of problems, and forecast future U.S. and world supply and demand for the nonfuel minerals and their impact on the domestic minerals industry. This information is used by Members of Congress and virtually every Federal agency which contributes to policies related to defense, the national economy, foreign relations, and, of course, minerals. The data is used by market analysts to plan capital investments in mines and processing plants, by public analysts examining the economy, by defense agencies in furthering national security, and by U.S. delegations in their work with NATO and international commodity groups. Cost recovery is achieved through the sale of publications, with prices based upon U.S. Government Printing Office (GPO) estimated sales in an amount that will cover GPO's cost for storage, printing, handling, etc. Publications sold by GPO include the Minerals Yearbook, Mineral Facts and Problems, special publications such as the "Minerals Data Source Directory," and "Mineral Perspectives."

To keep this information current and complete, commodity and foreign country specialists coordinate their work with numerous Federal agencies such as the Departments of Commerce, Defense, State, Transportation, and Treasury, the Central Intelligence Agency, the Council of Economic Advisors, the Federal Emergency Management Agency, and the Office of the United States Trade Representative. They also cooperate on a continuing basis with the Congress and the General Accounting Office as well as organizations engaged in international mineral reporting, including the American Bureau of Metal Statistics, the Gold Institute, the Organization of American States, the Organization for Economic Cooperation and Development, the International Bauxite Association, the International Fertilizer Association, the International Lead and Zinc Study Group, the International Tin Council, the Silver Institute, the Statistical Office of the United Nations, the Tungsten Committee of the United Nations Conference on Trade and Development, and the World Bureau of Metal Statistics. Foreign government organizations such as Australia's Bureau of Resources, Geology and Geophysics, Canada's Department of Energy, Mines and Resources, and the United Kingdom's Institute of Geological Science are also consulted.

Minerals information is disseminated through a variety of publications, special studies, meetings, and frequently by telephone to widely diversified groups. For example, an estimated 1,500 calls are received monthly by mineral commodity and foreign country specialist. The principal users of Bureau of Mines minerals information publications include, by sectors and occupations:

<u>Sector</u>	<u>%</u>	<u>Occupations</u>	<u>%</u>
Mining and exploration.....	20	Scientist/engineer.....	22
Government agencies.....	13	Company officer.....	21
Other manufacturing.....	12	Librarian.....	13
Metal processing.....	9	Market specialist.....	12
Universities and colleges...	8	Economist.....	9
Consulting.....	7	Writer/editor.....	5
Marketing and trading.....	7	Financial analyst.....	4
Financial.....	5	Teacher/Professor.....	4
Trade association.....	5	Association executive....	4
Media.....	4	Statistician.....	2
Transportation.....	3	Other.....	4
Other.....	7		
	100		100

Data Collection and Dissemination is supported by the AMIS which processes the data gathered in Bureau canvasses of the minerals industry and by other Mineral Information Systems activities that set uniform standards to guide data collection, document the procedures, and improve the statistical methodologies for data collection. Minerals supply and demand data is utilized in conducting studies and analyses as a basis for minerals policy assessment and development and for land assessment decisions. Information on minerals supply and demand is also used in guiding and prioritizing Bureau research.

MINERAL DATA ANALYSIS (MDA)

There are four program areas in the Mineral Data Analysis program: policy analysis, mineral availability system (MAS) development, land assessment, and state and regional studies and data gathering.

Specific programs in these areas are carried out in Washington and in three Bureau field operations centers--

Intermountain Field Operations Center (IFOC)
Western Field Operations Center (WFOC)
Alaska Field Operations Center (AFOC)

Each field center is involved in each of the four program areas.

Mineral Policy Analysis

The Bureau conducts long-term comprehensive studies which provide information and analysis of conditions and developing trends in the mineral industries to private and public decisionmakers. As a result of these studies, the relationships among the mineral industries and other sectors of the economy is better understood.

The Bureau also conducts short-term analyses usually in response to external requests. A typical analysis may examine the effect of actions by a foreign government on world mineral supply or the impact of a major environmental regulation on the minerals industry.

Minerals Availability Program

The mission of this program is to perform engineering and economic evaluations of worldwide (primarily market economy countries) availability of nonfuel minerals important to the economy and national security of the United States. Approximately 2,400 of the world's largest deposits of the major nonfuel minerals are being evaluated. Products range from data printouts of geological and engineering information to discounted cash flow analyses of individual mining operations and commodity availability analyses. This work supports analysis of national and international problems and Government policies that affect mineral supply and demand.

Mineral Land Assessment

This program provides Congress and the Federal land managing agencies with mineral information essential to balanced land-use decisions. More than 30 statutes require that mineral values be given adequate consideration in reviews of public lands for wilderness designations. Mineral surveys are made on designated wilderness areas, roadless areas, primitive areas, wilderness study areas, and other areas specified by the Forest Service and the Bureau of Land Management. The results of the surveys are presented in reports which are provided to these agencies and the Congress.

In addition, site-specific investigations are conducted on public lands primarily to find critical and strategic minerals. Most of that work takes place in Alaska which has the greatest potential for such minerals.

State Activities

Through a national network of 14 State Activity Officers, located at Bureau centers, effective liaison between the States and the Federal Government is provided. Through personal contacts, mineral information concerning Federal programs and policies and State problems and issues are exchanged with State agencies, mining associations, mineral companies, and the general public. As a result of such contacts and a knowledge of State mineral information and issues, State-related mineral publications are developed.

Mr. HORTON. Thank you, Mr. Chairman. I would be pleased to answer your questions.

Mr. REID. Thank you very much. In reviewing the budget and your written testimony, I note that the Bureau currently has six minerals and materials regional research centers. How will the proposed budget reductions affect the operation of these centers?

Mr. HORTON. We have six centers that are concerned with minerals and materials. We have 4 others for a total of 10. The four others are concerned with mining. The budget and the staff ceiling will require that we close some of the research centers.

Mr. REID. Do you know which ones?

Mr. HORTON. We are currently studying to determine which centers should be closed. We are looking, in the minerals and materials area, at three of them at the present time—not to close all three, but trying to make a selection between Avondale, MD; Rolla, MO; and Tuscaloosa, AL. A choice will have to be made between Avondale by itself or Rolla and Tuscaloosa combined.

The staffing at the centers, as the Bureau has reduced its staff over the past 2 or 3 years, is now small enough that further reductions across the board at each research center would result in ineffective use of space and facilities. It would be more effective to close those centers and consolidate the activities at the remaining centers.

Mr. REID. The one at Rolla—it's my understanding that it received two very significant industrial research awards this past year—one for soft soldering of aluminum and one for battery lead recovery. Is that right?

Mr. HORTON. Yes, it is.

Mr. REID. You have indicated that there will be some research personnel lost. Do you know how many?

Mr. HORTON. Our budget reduction from 1985 to 1986 will require that we reduce our staff by 155 people. Approximately 100 of those will have to come out of the research centers. Rolla has about 65 people; Tuscaloosa about 60; and Avondale a little over 100. That's why it must be either Avondale or a combination of Rolla and Tuscaloosa. We would not anticipate losing all those people, but transferring some of them and we have not yet identified all the numbers. We will transfer some of those to the remaining centers so that we may protect and continue some of the excellent work they've been doing.

They're not being selected or identified early for closure because of the poor grade of work that they do but Tuscaloosa and Rolla happen to be our two smallest centers.

Mr. REID. Who will conduct the research that is presently being conducted?

Mr. HORTON. That which we are able to continue through our budget will be transferred to other centers. The remaining ones I would be unable to identify.

Mr. REID. Mr. Horton, you've indicated, as I understand your testimony, that about 150 people would have to be cut from your personnel. Is that what you said, 150?

Mr. HORTON. One hundred and fifty-five.

Mr. REID. In looking at the budget of the Department of the Interior for fiscal year 1986, that budget authority level is \$5.6 billion. That is some \$966 million below last year's appropriated level. Out of the 2,496 positions that are slated for reduction in that very large budget, 150 of them are coming from your very small agency. Are you aware of that?

Mr. HORTON. Yes, sir.

Mr. REID. Mr. Horton, as I indicated in the opening statement, I am concerned about minerals. Mines are closing all over the country. We have some of our allies who are in very unstable political situations. Do you feel that it's important that we continue the research that is being done in these institutes and in your agency generally?

Mr. HORTON. Yes, to argue otherwise would be to argue that the research we have done has not been productive or that that which is being done in the Mineral Institute is not productive. That's not our position at all.

Mr. REID. You know, and I know you work closely with, Jim Santini who was chairman of the Minerals and Mining Subcommittee on the Interior before he retired. He stressed continually the need for the United States to do more about developing our mineral industry for some of the reasons that I've already stated. Has Federal policy changed regarding mining and minerals that you're aware of?

Mr. HORTON. Not that I'm aware of, no, sir.

Mr. REID. So it's still a very high priority as far as you know that we need to do something about maintaining our mineral independence?

Mr. HORTON. There is considerable concern within the administration concerning that very point. The reduction in the budget reflects the President's greater concern with the deficit.

Mr. REID. I understand that Mr. Stockman—maybe he doesn't understand the importance of mining and minerals.

Mr. HORTON. We do our best to educate all those within the administration.

Mr. REID. Do you know why then there's such a severe impact upon your budget in the overall cuts for—about 25 percent of the cuts in personnel alone are in your little agency.

Mr. HORTON. I feel I must point something out to you. The numbers to which you refer are the comparison between the fiscal year 1986 base budget and our proposed fiscal year 1986 budget.

Mr. REID. I understand. It's still a lot of people.

Mr. HORTON. There is a more favorable comparison between the fiscal year 1985 appropriations and the fiscal year 1986 estimate. In any event, yes, the Bureau of Mines is taking what appears to be a disproportionate share of the Department of the Interior's cut. Unfortunately, not all agencies are able to take an average cut and the cuts assigned to the Bureau of Mines are those which the Department, in consultation with the administration, feels are appropriate.

Mr. REID. Mr. Horton, let me ask you this. What is the state of the United States as far as mineral readiness, for lack of a better word, this year compared to 5 years ago? I'm not making that a political question, I'm just using it as a point in time. Are we getting more independent or less independent?

Mr. HORTON. We are less independent now. One would have to say this because the production of many of our metals is down. We import more metals today than we did 5 years ago.

Mr. REID. Your being an old miner and being from a State whose second most important industry is mining, that gives you some concern, doesn't it?

Mr. HORTON. Indeed it does.

Mr. REID. Mr. Lewis?

Mr. LEWIS. Thank you, Mr. Chairman. In your testimony, Mr. Horton, you have placed heavy emphasis on national security; almost two pages out of four. While the committee shares your concern for minerals import vulnerability shouldn't we be equally or even more concerned today with the overall health of our domestic minerals industry as a whole?

Mr. HORTON. Well, the Government's first concern must be with the security of the country and perhaps that is why we have chosen to put heavy emphasis on national security. You can't divorce mineral readiness for national security from a healthy mineral industry. An unhealthy mineral industry would not support national security, so they're part of the same problem.

Mr. LEWIS. What is the Bureau's role in this crisis and what steps are you taking to help the minerals industry?

Mr. HORTON. I would hope through our continued research and our input through studies that are made by other agencies—we have had substantial input to the International Trade Commission and others studying the copper problem and some on iron—decisions that have come out of our work and the petitions filed by various segments of the mineral industry have not been acted upon in a favorable fashion in the eyes of the mining industry.

Some of that, again, reflects the President's insistence on open trade.

Mr. LEWIS. Should the Bureau put special emphasis in those areas that have national security implications?

Mr. HORTON. Yes, and we are doing that. We are increasing the proportion of our budget that is directed toward the strategic and critical minerals: chromium, platinum, and cobalt in particular.

Mr. LEWIS. A moment ago you mentioned copper and you were quoted in a recent Washington Post story on March 30, 1985, as saying, "Let's face it. What's happening with copper is what we are supposed to want to happen. The developing countries are in fact

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Mr. HORTON. Well, I would hope that support would not be eliminated but that support would be provided by industry and by the States—those directly concerned with the issue.

Mr. REID. Do we need new engineers and scientists in the materials and mining fields?

Mr. HORTON. At the moment, we don't need more. There is substantial unemployment—

Mr. REID. That's because of the down trend in the mining industry, generally, isn't that right?

Mr. HORTON. There is no question that we need better—not to take shots at my peers in the profession—but, we do need and will continue to need a higher quality of graduate; one which is better based in engineering fundamentals and in world economy in mineral management.

Mr. REID. Mr. Horton, my question is: Isn't this shortsighted? If we expect the mineral industry to pick up, even a little bit, we'll have a shortage of mining engineers. They've gone into different fields. They're doing different things. So, isn't this short sighted?

Mr. HORTON. No, I believe that the administration's position is a proper one and that the funding and support for those institutes should be provided by industry, the States, and those more directly concerned.

Mr. REID. Well, we know that the companies are really having economic problems themselves. Do you acknowledge that?

Mr. HORTON. Indeed.

Mr. REID. Isn't it stretching things to think that they're going to help finance these? That's really a luxury as far as they're concerned. You know they laid off thousands of people in Utah and Arizona. Isn't this wishful thinking?

Mr. HORTON. Industry will have a difficult time but the Mineral Institutes vary widely in the funding that they receive elsewhere. We've done some studies in the past and can make those available. The studies that we have are incomplete and it's difficult to identify the total funding for the Mineral Institutes. At some universities the Mineral Institute consists of brick and mortar and people. In others, it's an entry on the books of the university and the funds flow through that accounting system to various professors or researchers within the institute.

I was recently in Kentucky attending a symposium with their institute. They receive \$80 million a year from the State. It reflects the large amount of coal mining that's in Kentucky. I wouldn't begin to suggest that all mineral institutes share in that.

Mr. REID. See, that's my point. One of my friends is president of the largest coal mining company in the world. They have money. They're doing well. They have money to invest in this. When we talk about most of our minerals companies in the United States, they aren't doing well at all. That's an understatement.

I think the point has been made. Mr. Packard, do you have any questions?

Mr. PACKARD. No questions, Mr. Chairman.

Mr. REID. We really appreciate your being here, Mr. Horton. Do you have anything else you would like to add prior to terminating this part of the testimony?

Mr. HORTON. No, I don't think so, Mr. Chairman.

Mr. REID. We will submit written questions and you can supply the answers to the committee.

Mr. HORTON. I would be enthused to do it.

Mr. REID. Mr. Glickman has some that he would like to ask.

Mr. HORTON. Fine. Thank you, Mr. Chairman.

[Additional questions for the record follow:]



OFFICE OF THE DIRECTOR

United States Department of the Interior

BUREAU OF MINES
2401 E STREET, NW
WASHINGTON, D.C. 20241

June 13, 1985

Honorable Dan Glickman
Chairman, Subcommittee on Transportation,
Aviation and Space
Committee on Science and Technology
House of Representatives
Washington, D.C. 20515

Dear Mr. Glickman:

As a followup to the oversight hearing on the Bureau of Mines, held by your subcommittee on April 24, 1985, enclosed are our answers to the questions you submitted. Please let us know if you need further clarification.

Sincerely,

Robert C. Horton
Director

Enclosure

MINERALS AND MATERIALS RESEARCH REDUCTIONS

Question: The November, 1983 report to this Committee in response to the 1980 Materials Act (P.L. 96-479) emphasizes significant increases in the budget for materials and minerals research between FY 1981 and FY 1984. Why is the Administration proposing to cut this research by 28%?

Answer: The decrease in the budget for Minerals and Materials Research is a result of the Administration's goal of reducing the budget deficit and the Bureau's continuing efforts towards an emphasis on basic, high-risk, generically-applicable research.

Question: What will be the effects of the cuts; i.e., what research programs specifically will be reduced? How are the decisions being made?

Answer: Achieving the reduction in the Minerals and Materials Research program necessitates terminating work performed for the Bureau of Mines by the private contractor, EG&G Idaho, Inc., that operates the Department of Energy's Idaho National Engineering Laboratory. In addition, lower priority, ongoing research at the Bureau's research centers will be reduced. These reductions include: pyrometallurgical methods of mineral processing, chemical treatment of predominantly base-metal sulfides, processing of domestic manganese resources, treatment of gold and silver ores, corrosion of grinding equipment, and field-testing of wear resistant materials for mining equipment. The decisions are based on work nearing completion and work that is of lower relative priority.

PROJECT 2000

Question: The Bureau, at your request, has been conducting, through "Project 2000", an analysis of mining and minerals to the year 2000. What is the status of that report?

Answer: The Project 2000 report is in its first draft. We anticipate completion of the report during the summer of 1985.

GOALS AND DIRECTIONS

Question: What do you believe should be the long-term goals and directions of the Bureau?

Answer: We believe the Bureau's general directions should be to:

Ensure that the United States has an adequate and dependable supply of minerals with maximum efficient contribution from the domestic mineral industry.

Reduce the human and economic costs of mining-related deaths, accidents, and illnesses.

Increase the beneficial use of advanced technologies and materials by the mineral industry and contribute to increased beneficial uses by U.S. producers and consumers.

Help ensure conservation of the Nation's mineral resources.

Promote informed and considered formulation and implementation of environmental, tax and other laws, rules, and regulations that impact the mineral industry.

Help ensure improved government, university, and industry cooperation in mineral related research and education to expand the Nation's mineral research base and improve professional competence.

Help improve water conservation practices of the mineral industry and assist in improving the quality of waters contaminated by mineral substances.

Question: How can you best achieve these goals, given the proposed reductions?

Answer: These goals have been and will continue to be the bases for directing Bureau activities and are not inconsistent with the resource reductions proposed in the budget. We intend to make optimum use of the resources provided to us in following these directions. We are now in the process of defining operational objectives in pursuit of those goals. Specific actions to accomplish the objectives defined in the report will be identified beginning in FY 1986, to be completed over a time period that has yet to be defined.

SELECTION OF BUREAU RESEARCH

Question: How are the research goals and directions of the Bureau currently determined?

Answer: All Bureau research efforts are selected on the basis of their potential contribution to achieving the goals of the Bureau, the degree to which they meet specific criteria defining the Federal research role, and their consistency with Administration policy as expressed in the President's National Materials and Minerals Program Plan and Report to Congress of 1982. The approach used is a formal two-tiered system that establishes the general direction of research efforts to be carried out by the Bureau. Bureau headquarters provides overall strategies to the Bureau's research centers for proposal submission based upon the priorities established for each area of research. The research proposals received from the Bureau's research centers are screened for their relevance to, and impact on Administration, Bureau, and programmatic goals and objectives by senior Bureau Headquarters managers and staff. This review looks at such criteria as: can the private sector do the work? Is the objective consistent with National goals? What are the chances of payoff? Are the time and cost realistic? Those research proposals that pass the initial screening are reviewed by evaluation committees composed of technical experts. Such experts from MSHA or OSM may be on these committees together with representatives from the Bureau. Each proposal is evaluated against a set of criteria, including the urgency of the problem which it intends to address, the probable success of the project in achieving its objectives, and the technical soundness of the proposal. Research projects found acceptable by the evaluation committees are placed into a research project pool in order of priority.

Question: What specifically is being done to involve industry and the university community in setting those research priorities? What more can be done?

Answer: Industry and the university community have both direct and indirect input into the research program carried out by the Bureau of Mines. A research idea may be initiated as a direct response to input from industrial trade associations, individual companies, or universities. These ideas can be formally submitted as unsolicited proposals or may be the result of the informal contacts between industry or university and Bureau personnel. In addition, industry communicates its research needs to the Bureau through technical interaction with Bureau personnel during cooperation on joint research projects. We believe that this process is working well, and that the Bureau's research efforts are responsive to the interests of the industrial and academic communities.

Question: Have you considered establishing an advisory committee of outside experts to recommend research priorities? If not, why not?

Answer: There is an Advisory Committee on Mining and Mineral Research established as required by section 9 of Public Law 98-409. This committee is preparing a national plan for research in mining and mineral resources which will be submitted to the Secretary of the Interior, the President, and the Congress by March 1986. The Bureau will consider the recommendations contained in that plan when it is completed.

Question: What is the cost-benefit of the major research efforts of the Bureau of Mines?

Answer: In recent years, Bureau efforts have been directed increasingly toward basic, high-risk, generically applicable research. Such research, by its nature, yields valuable new information but only rarely "products" which are immediately commercially marketable. Frequently, many years pass before the new information is used commercially. Industry invests additional resources to advance the Bureau's proof-of-concept research results to specific commercially salable products or processes. Thus, the cost-benefit of Bureau research, like most research of this character, is extremely difficult to calculate.

However, Bureau research has produced several developments that led directly to conspicuous commercial success:

iron ore ... Bureau funded approximately \$3 million of research that resulted in a patented technological breakthrough that, in turn, led directly to construction by the Cleveland Cliffs Iron Company of a new \$600 million plant employing 1025 workers in Michigan. The plant can process 8 million tons of high-grade iron oxide per year. Literally hundreds of millions of dollars have been generated from iron ore production by this process. For iron ore, the U.S. capacity was increased 10 percent as a direct result of Bureau research.

Using the Bureau's agglomeration pretreatment technique for precious metal ores and tailings, more than forty operators have increased recoveries by as much as 50 percent.

Other research such as quieting pneumatic drills and reducing mine dust levels will yield large, but difficult-to-quantify, savings as a result of fewer disability claims.

Question: Can you provide us with specific details of exceptionally beneficial research results; for example, the sulfur concretes, soft soldering of aluminum, and electrogalvanizing?

Answer: The following are some exceptionally beneficial accomplishments of the Bureau research:

Portland cement will deteriorate in a short time under exposure to corrosive salt or acidic conditions. Bureau research to address this national problem, which is widely prevalent in the mining and minerals industry, resulted in a high-performance, corrosion-resistant new material, sulfur concrete. Sulfur concrete is a construction material based on plasticized sulfur and mineral aggregate. Sulfur concrete, full-scale industrial floors (each 20,000 square feet) recently have been installed at two major electrolytic metal refineries, Asarco Zinc Refinery, Corpus Christi, Texas, and Cities Service Co. Copper Refinery, Miami, Arizona. Seven U.S. companies already have been licensed to produce sulfur concrete, and others, worldwide, are considering becoming licensees.

Until recently, no practical soft soldering system was available to repair broken items made of aluminum. Consequently, the broken parts were scrapped and replaced by new ones, which were costly to the consumer. A system has been developed by the Bureau of Mines that now will permit repair of many aluminum items with common tin-lead "soft" solders. The National Automotive Radiator Service Association has conducted regional workshops together with the Bureau of Mines to demonstrate the new soldering method to its 15,000 members. The method is so simple that it can be used readily in a home workshop. For this accomplishment, the Bureau received an "IR-100 Award" in 1983. These awards are presented annually by the "Industrial Research and Development" magazine for the 100 best technological achievements in the country.

The Bureau has shown that smelter dusts having a high zinc content, which are currently wasted, can be used in commercial wire electrogalvanizing operations instead of virgin zinc. Although wire electrogalvanizers do not consume significant quantities of zinc, U.S. steel companies are optimistic that this research, which is still in the early stages of development, will be directly applicable for sheet steel electrogalvanizing production lines now being installed. Six sheet electrogalvanizing production lines are scheduled for domestic use by the U.S. automobile industry. One line is being planned by a single steel company and others are scheduled for construction by joint ventures (e.g., Bethlehem Steel Corp. and Inland Steel Co. have combined with an independent coil coating co.). In order to meet the U.S. automobile industry goal for 10-year guaranteed rust protection, additional quantities of electrogalvanized steel sheet will be required.

Worn cutting and drilling bits comprise a very high-value scrap containing cobalt and cemented carbides. Although some of these high-value materials could be processed for recycling, the methods are either slow or expensive and only 70 percent of the contained hard constituents are recovered as usable products. The Bureau of Mines developed a simple, cheap, and efficient process using molten zinc to separate the desired components. This technology produces high-purity products with no wastes, and the zinc can be recycled. Some of the companies that have adopted the technology include: Wah Chang, Kennametal, Sandvik, G.E. Carboloy, Metallurgical Ind., CTE Sylvania, and Transition Metals.

Etching solutions containing chromium are used for various types of surface treatments. With use, the effectiveness of the solutions decreases until etching is no longer satisfactory, and the spent solutions are discarded. The Bureau has developed technology for the economic regeneration and recycling of the spent solutions, thereby greatly reducing the amount of chromium required during etching operations and minimizing waste disposal problems. Two industrial facilities--Imperial Clevite, Inc., Niles, Illinois, and Rexnord Corp., Downers Grove, Illinois, have installed commercial units following successful Bureau in-plant demonstrations.

Question: How does the cost-benefit compare with research programs in other agencies (DOE, DOC, NSF, NASA)?

Answer: In addition to the difficulty in determining the cost-benefit of Bureau research, we have not been provided cost-benefit data on programs from other agencies. Since much of the research conducted by the agencies listed also is basic research, calculating cost-benefit ratios for it would be fraught with the same difficulties explained above in regard to the Bureau research. As a result, we cannot compare the cost-benefit of our research to that of other agencies.

Question: One important result of research conducted by the Bureau is the new sulfur concretes for corrosion control on the nation's highways. What are the expected economic benefits of using these new concretes?

Answer: The Bureau's sulfur utilization research has successfully addressed three new uses of sulfur:

- o sulfur concrete
- o sulfur-extended asphalt
- o sulfur additions for recycling asphaltic paving materials

Sulfur concretes have been developed by the Bureau as construction materials with physical and mechanical properties that make them suitable for use in corrosive acid and salt environments where conventional portland cement concrete fails. As a corrosion-resistant material, sulfur concrete can be used for acid-proof leaching tanks, reaction vessels, sumps, and for handling sewage and wastes that contain acids and salts. Sulfur concrete sets upon cooling and attains 80 pct of its ultimate strength within 24 hours. Consequently, it has potential for use in road pavement as a base or surface material that must be placed in service quickly. Other potential uses are for salt-resistant bridge decking and repair of potholes. The cost of installing sulfur concrete is about twice that of portland cement concrete (i.e., \$100 cu yd vs \$50 cu yd). However, the additional cost is offset by the savings in maintenance and replacement costs. For example, test slabs of sulfur concrete placed in an industrial location with exposure to dilute sulfuric acid were in good condition after two years, while control slabs of portland cement concrete had completely disintegrated. Sulfur concrete, full-scale industrial floors (each 20,000 square feet) have been installed at two major electrolytic metal refineries and show no signs of corrosion or deterioration after four years.

Question: What is being done to exploit this new discovery?

Answer: The Department of Commerce, National Technical Information Service, selected Bureau sulfur concrete technology for patenting and licensing in the United States and 20 foreign countries. Several contracting and chemical manufacturing companies have licensed the technology in the United States and currently are manufacturing the sulfur cement and concrete for commercial use.

Sulfur-extended asphalt (SEA) technology developed by the Bureau has been used in highway paving test sections throughout the United States. Thirty-five states have SEA paving sections under evaluation. Sulfur can be used as a direct replacement for up to 50 pct of the asphalt in conventional paving mixtures. As the request of the Federal Highway Administration, workshops were given for Federal and State highway officials on SEA paving. A state-of-the-art manual has been published for use in design, quality control, and construction of SEA paving. Currently, failure analysis techniques are being developed under a cooperative agreement with The Sulphur Institute to assist State agencies in evaluating the new materials.

Methods for recycling spent asphalt paving materials mixed with sulfur have been prepared and evaluated both in the laboratory and as patches on city streets. Highway sections made with mixtures of recycled asphaltic paving materials and sulfur are being tested in Minnesota, Wisconsin, and Georgia.

Question: What was the result of the Bureau's recent workshop on these concretes held here in Washington?

Answer: The Bureau and The Sulphur Institute jointly sponsored a briefing session on sulfur concrete on April 17, 1985. The briefing was attended by 20 representatives of 6 U.S. companies and 5 representatives from 5 foreign countries. The objective of this briefing was to ensure that the Bureau's work is effectively transferred to the private sector and to provide participants with background information on sulfur concrete materials. In addition, discussions were held on how industry could best advise the Bureau on technological problems that should be solved so that the full potential of sulfur concrete can be realized.

Question: Do you plan to increase R&D in this area?

Answer: Bureau funding for research and development in this area is projected to remain at about \$150,000 a year. The Sulphur Institute contributes \$25,000 a year to the project.

Question: Dr. Keyworth of OSTP is pushing a new steel initiative through the Federal energy laboratories. What has been the involvement of the Bureau in this initiative? Why hasn't it been greater?

Answer: The Bureau has had no involvement in Dr. Keyworth's steel initiative. However, beginning about 1 1/2 years prior to Dr. Keyworth's initiative, the Bureau began to develop its own steel research plan in consultation with representatives of the industry and in relation to the restructuring of the industry that then was beginning to take place. In August 1983, advice from the steel industry was sought through the American Iron and Steel Institute to determine how the types of research the Bureau was considering fit together with research the industry was planning to undertake. Collaboration on this effort continued with the steel industry until Dr. Keyworth's initiative was made public.

Although the Bureau is not participating in this research initiative by OSTP, the Bureau has a minor research effort related to steelmaking. An electric furnace has been instrumented so that every few seconds the electrical current and voltage are recorded. These data, combined with high speed movies and furnace operating conditions, allow detailed studies of conditions that effect arc stability in a furnace during melting. The results will be useful for improving furnace efficiency, leveling power demand, and reducing noise levels.

Question: A number of minerals and materials processing research programs exist in NSF, DOE and elsewhere. How do you coordinate your research efforts with those of other agencies?

Answer: Research is coordinated with other Federal agencies through both formal and informal arrangements that include meetings, workshops, briefings, and personal contacts. Some of these agencies include: Department of Defense, Department of Energy, Department of Transportation, National Aeronautics and Space Administration, Environmental Protection Agency, National Bureau of Standards, and United States Geological Survey.

Question: How are responsibilities assigned in each of the agencies?

Answer: Responsibilities are based on the agency's mission as defined by authorizing legislation and by allocations of budget resources through appropriations.

Question: What measures are being taken to avoid duplication?

Answer: Duplication is avoided by maintaining an awareness of research being conducted in other Federal agencies. This awareness is accomplished through discussions, personal contacts, and observing research underway at other agencies.

Question: How much of your research efforts require or indicate cost sharing?

Answer: No cost sharing is required. However, cost sharing of research with industry remains an integral part of the Bureau's Minerals Research activity.

Question: How can you expand industrial cost sharing? In what areas?

Answer: In order to minimize the required government funding to conduct research and enhance the transfer of technology, the Bureau has tried to maximize the utilization of industry in the latter stages of the Bureau's research into new technologies. The result has been excellent and about 150 Memorandums of Agreement currently exist covering all major research areas. The total estimated value of these agreements is \$600,000. The Bureau will continue to encourage industry to participate in cost-shared research efforts and expand them whenever possible.

Mr. REID. Thank you. The next witness that we are anxious to hear is Dr. Simon Strauss of the American Mining Congress. Dr. Strauss, will you come forward please.

Dr. Strauss, we have had the opportunity of reviewing the written statement that you have given us. If you would take a few minutes and summarize your statement so that we can ask you some questions.

**STATEMENT OF DR. SIMON D. STRAUSS, AMERICAN MINING
CONGRESS, WASHINGTON, DC**

Dr. STRAUSS. Thank you, Mr. Chairman. I am accompanied this morning by Mr. J. Allen Overton, Jr., who is the president of the American Mining Congress. As my statement indicates, I am testifying on behalf of that organization and I'm the immediate past chairman of its minerals availability committee. The congress felt that it would be appropriate to ask me to be the witness this morning in view of your concern about national security and dependence on minerals which is an issue with which I am quite familiar.

I suspect you're familiar with the American Mining Congress. It's been in Washington a long time. It represents the producers of most of America's metals, the manufacturers of minerals and mineral processing machinery, and also the engineering and consulting firms that serve the mining industry.

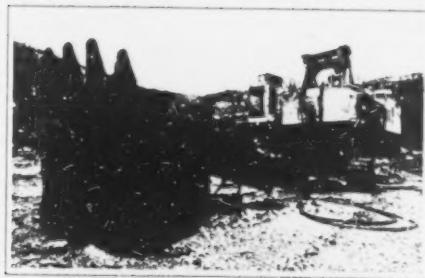
I would like to say that, as your questions indicate, you're already very well aware of the distressed state of the American mining industry. I've been active in the mining business for more than 50 years and I can say that the state of the industry today is as bad as it was at the depths of the Great Depression of the 1930's. The situation is extremely difficult. Mr. Horton referred to the strong dollar. Just as in the case of the farming industry, I think the mining industry is adversely affected by the fact that a strong dollar means that its costs are rising in relation to the costs of its overseas competitors whose costs are being cut as their currencies lose value in relation to the dollar.

The plight of the industry has been well indicated by the issue of *Business Week*, perhaps this country's leading periodical, that actually had a front cover that said, "Death of Mining." That was published just in December of last year——

Mr. REID. This right here, right?

[Material referred to follows:]

Cover Story



THE DEATH OF MINING

AMERICA IS LOSING ONE OF ITS MOST BASIC INDUSTRIES

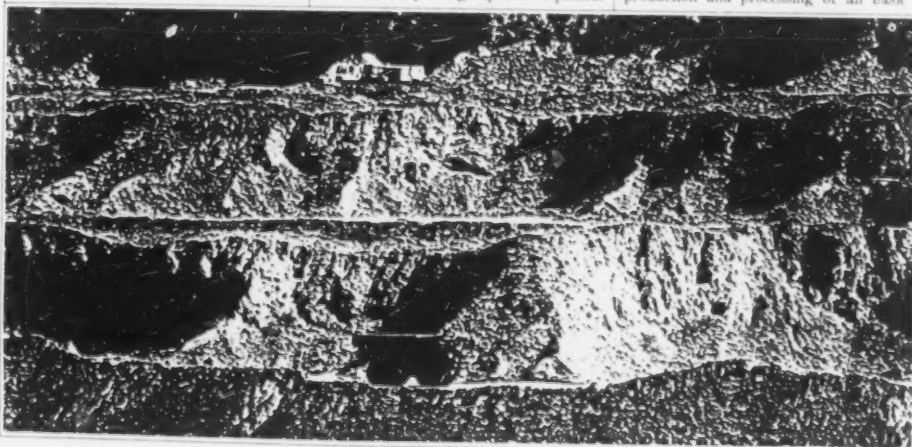
Just south of Tucson, a two-lane highway rolls through the desert to Mexico. Along one 26-mi. stretch, it skirts five open-pit copper mines amid the saguaro cactus, mesquite, and ironwood. This is U.S. 89, known as *el camino de la muerte*—"road of death"—for the toll it has taken on drivers zooming north from a hard-drinking night in the border town of Nogales. But the macabre name might just as easily refer

to the mines that line this lonely road. Once the workplaces of thousands, they are now either closed or up for sale—a stark reminder of the sad state not only of U.S. copper companies, but of most of the rest of the North American metals mining industry.

The recovery of 1983-84 largely bypassed producers of copper, iron ore, nickel, lead, zinc, and molybdenum. Now, after a prolonged period of painful

losses, these companies are reeling from what are clearly chronic problems: shrinking markets, huge debt, and depressed prices. Three or four major metals producers may even be forced out of the business over the next few years. In a very real sense the industry is dying.

The pangs of mining are the latest example of what may be an industrial megatrend: the inexorable shift of the production and processing of all basic



materials from the industrial countries to the Third World. Like steelmaking, metals mining is vulnerable to some fundamental forces. It is an industrial activity in which, these days, the developing nations have an almost unbeatable pair of economic advantages: cheap labor plus very-low-cost reserves.

The industry's plight ripples far beyond the dozen or so companies that dominate metals mining in North America. Just four years ago, metals mining in the U.S. was an \$8.9 billion enterprise. By 1983 it had shrunk to just \$5.9 billion. Mining employment, already down to 44,800 at the start of this year from 109,000 in 1981, could fall a further 30% over the next two to three years. The contraction is already creating modern-day ghost towns (page 68) in mining regions of the country. And while lower metals prices do mean at least a short-term benefit for manufacturers and consumers, some observers are concerned that the industry's problems may one day put national security at risk. "We need a copper industry, for defense purposes if nothing else," asserts Representative Morris K. Udall (D-Ariz.), chairman of the House Interior Committee.

REAL DANGER. For all these reasons, metals mining could become the next *cause celebre* in Washington's continuing debate over industrial policy. Many officials within the Commerce, Defense, and Interior Depts., as well as in Congress, now believe the U.S. may soon have to choose between forgoing major segments of its minerals-producing capability and subsidizing them. "We are in real danger of losing 75% of our copper industry and 40% to 50% of our iron-ore industry," warns Robert C. Horton, head of the Bureau of Mines. All across the mining spectrum the signs are plain:

□ The largest copper producers—Kennecott, Asarco, and Phelps Dodge—are deep in the red again this year. Phelps Dodge lost \$50 million in the first nine months. Kennecott Corp.'s \$41 million operating loss in metals during the third quarter brings its total loss in the business since 1981 to \$483 million. Asarco Inc., which suffered a net loss of \$70 million in the first nine months of 1984, had to cancel its fourth-quarter dividend.

□ The major oil companies—which once rushed into metals as the next best thing to oil—are already giving up. Last month, Pennzoil Co. took a hefty \$100 million write-off to reflect the decreased value of Duval Corp., its copper and molybdenum mining subsidiary. Three months earlier, Atlantic Richfield Co. took a \$785 million write-off on Anaconda Minerals Co., a copper and metals fabricator it purchased in 1977 for \$680 million. Both companies have put their metals operations on the block.

□ In iron ore, U.S. Steel, Hanna Mining, and Pickett's Mather announced in November yet another round of temporary mine closings that will shut down most of Minnesota's iron-ore Mesabi Range this winter. Days later, Canadian steelmaker Stelco Inc. announced that it was permanently closing its Griffith Iron Ore Mine. That added a further 1.5 million tons of ore-producing capacity to the 25 million that has been shut down for good in the U.S. and Canada since 1980.

□ In nickel, zinc, and lead, the scene is much the same. Toronto-based Inco Ltd., a giant nickel producer, has posted 13 consecutive quarters of operating deficits. Noranda Inc., a major zinc and lead

producer, lost \$38 million in the third quarter, wiping out its first-half profit.

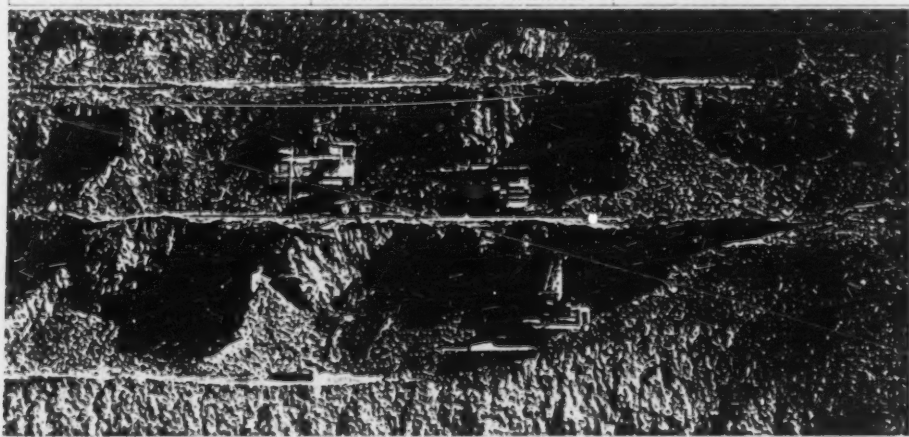
A series of factors accounts for mining's malaise. The industry is hobbled by a worldwide excess of capacity that shows no sign of abating. Despite disappointing demand for most metals, Third World countries, eager to exploit more of their natural resources, keep opening giant new mines that incorporate the latest recovery techniques. The strong dollar makes their low-cost products particularly appealing to U.S. buyers. Underlying all this is a weakening geological base: Many of the richest domestic base-metal reserves are coming close to depletion, while the low-grade ore that remains is becoming too costly to recover.

In their day, North American mining companies ranked among the world's industrial elite. Amax, Anaconda, Asarco, Kennecott, or their forerunners helped settle the West. Huge family fortunes derived from mining, including the Hearsts' and the Guggenheims'. Mining companies were among the first U.S. multinationals, dominating world markets during the boom that followed World War II. Amax Inc. once held 50% of the Free World market for molybdenum, a metal used in everything from light bulbs to jet engines. Inco once supplied 90% of the world's nickel.

WILD FLUCTUATIONS. Things began to change in the 1970s. Copper and iron-ore mines in South America and Africa were expropriated. The North American industry was hit with large environmental expenditures. New competitors from the Third World appeared, many of them state-owned and blessed with abundant reserves.

Price-setting, once the province of the North American oligopolies, shifted to

PENNZOIL'S SIERRITA COPPER MINE IN ARIZONA. THOUGH UP FOR SALE, IT HAS SO FAR SURVIVED BY CUTTING WAGES AND BENEFITS AND EXTENDING WORK HOURS



Cover Story

the floors of the world's commodities exchanges, chiefly the London Metal Exchange. Steady prices yielded to the wild fluctuation, now the norm in the business. Demand for iron ore, nickel, and molybdenum started to wobble as the biggest customer for all three metals—the U.S. steel industry—faltered.

But the most devastating blows came with the recession of 1981-82. After hitting record, or near record, levels in 1979 and 1980, earnings of the North American producers collapsed. From 1982 through this year's third quarter, 10 of the largest independent North American mining companies reported net losses totaling \$1.8 billion. At the start of 1981, their debt amounted to 36% of their capitalization; by the end of this year's third quarter, it was close to 41%—at least 10 percentage points above the average for U.S. industry. Return on shareholders' equity, which stood at 18% five years ago, is likely to end up this year at minus 1%. On average, the shares of the U.S. metals mining companies in the group sell for 36% below book value.

The situation has grown so grim that Interior Secretary William P. Clark, who last fall tried to win import relief for copper producers, is now publicly voicing his alarm. Worried about U.S. dependence on foreign minerals, Clark has ap-

pointed a 25-member task force to search for ways to preserve the nation's remaining mines. In mid-November, the panel, headed by retired Rear Admiral William C. Mott, issued its first substantive proposal. It called for the U.S. strategic metals stockpile to be placed in the hands of a Comsat-type, quasi-government corporation instead of several agencies. A single entity presumably could make decisions more smoothly than the present mix of overseers can.

ROCKS IN WATER. The industry's most visible problem is prices, which have lately had all the buoyancy of rocks in water. Even though strikes have curtailed 63% of U.S. lead mining capacity since summer, lead has nonetheless fallen an additional 5¢ a lb. since July. Although inventories of copper on the London and New York exchanges have dropped 50% since January and world demand for the metal may hit a record 8.3 million tons this year, copper is now 61¢ a lb.—9¢ below its price last April.

"These are not normal economics as we have known them," says Asarco President Richard de J. Osborne. "Based on the fundamentals and on historic precedent, we should now be several quarters into a price recovery." Yet, in real terms, the price of copper is lower now than at any time in this century except

during the trough of the Depression.

Industry executives lay much of the blame on the mighty U.S. dollar, which has allowed foreign producers to offer metal to U.S. buyers at low prices and to maintain—or even fatten—profit margins in their own currencies. Grumbles Inco's Chairman Charles F. Baird: "The U.S. dollar is killing us." Some executives are hoping the dollar will soon weaken. But even if it does, it may be too little, too late. "The concept of currency devaluation is overblown," argues Brian E. Felske, a Toronto-based mining consultant. "A 10% decline will do some good, but it isn't going to bring copper producers back to profitability."

Moreover, a declining dollar does not necessarily mean that the price of copper, lead, and molybdenum will rise, notes Firoze E. Katrak, a vice-president of the Boston commodities research firm Charles River Associates Inc. The reason: Even in times of glut, world producers set their prices on the direct operating costs of the most expensive mines—which happen to be in the U.S. A lower dollar would thus affect neither production costs nor market prices in the U.S.—and would also have no bearing on worldwide supplies or demand. Although Katrak believes prices just might rise moderately over the next few years,

WHY CHILE IS THE KING OF COPPER



CHEAPER LABOR. CODELCO MINERS' WAGES ARE HIGH BY CHILEAN STANDARDS—BUT ONLY A TENTH OF WHAT U.S. MINERS EARN

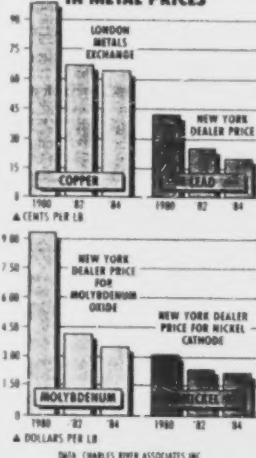
he thinks they will more likely languish near present levels. He predicts that copper will sell for less than 90¢ a lb., in constant dollars, through the rest of the century and that nickel and lead prices will stagnate into the 1990s. The price of molybdenum, he predicts, will remain weak through 1987.

A significant increase in volume also seems far off. Metals experts almost all agree that demand will hold steady, or at best grow modestly, over the next decade. Cleveland-based Hanna Mining Co. is forecasting that North American consumption of iron-ore pellets will average no more than 74 million tons a year through 1990—a far cry from the 109 million tons consumed in the peak year of 1979. Demand for copper, nickel, lead, and zinc is seen increasing by only 1% to 2% for the next 10 years.

A host of factors is curbing growth. New materials, such as plastics and optic fibers, are replacing metals in many product lines. Katrak estimates that, by 2000, technological advances will enable manufacturers to use only two-thirds as much copper per unit of output as they do today. Lead is being banished from gasoline, its second-biggest market, while longer-lasting, lighter batteries are slowing consumption in its primary market. More and more metals recycling is occurring almost everywhere.

In the few markets where demand

THE PLUNGE IN METAL PRICES



continues to grow respectably, supplies keep growing as fast or faster. According to Katrak, world molybdenum consumption may increase 3.5% a year through 1990. But so many new molyb-

denum mines have opened up during the past five years that annual capacity is now 69% greater than the 166 million lb. expected to be consumed next year.

For many struggling producers of North America, the telling factor is the decline in the grade of their ore. "The high-grade, easily accessible deposits have been mined out" in the U.S., says John W. Goth, Amax's senior executive vice-president. Most of the richest deposits now are in developing countries. That is a major reason why the giant Corporación Nacional del Cobre de Chile (CODELCO) is now the world's foremost producer of copper (below).

Similarly, Cia. Vale do Rio Doce, the Brazilian state-owned mining company, will be the world's premier iron-ore producer when its giant Carajás mine comes on stream next year. Not only does Carajás contain 20 billion tons of the world's richest iron ore, but Brazilian labor costs are 78% lower than those at U.S. mines. By 1988, output could hit 35 million tons a year—nearly as much as the entire U.S. produced last year.

'UNCONSCIONABLE' LOAN. It is unlikely that Carajás ore will flood the U.S., since domestic steelmakers have a huge investment in North American iron-ore mines and processing facilities. But Japanese and European steelmakers have signed long-term contracts that should allow them to buy Carajás ore for even

If Chile is the Saudi Arabia of copper, Corporación Nacional del Cobre de Chile (CODELCO) is the Petromin of Chile. Formed as the successor to five mining companies nationalized in 1971, this state-owned giant is blessed with more than 25% of the world's known copper reserves. Its gargantuan Chuquibambilla mining and processing complex yields ores with 1.65% copper—2½ times what a typical U.S. deposit contains. At 44¢ per lb., CODELCO's production costs are the world's lowest. Not surprisingly, it accounted for 16% of all copper mined by non-Communist countries last year.

While sheer size gives CODELCO operational advantages, its rock-bottom labor costs are what make competitors weep. Although its 26,000 workers earn only a tenth of what U.S. copper companies pay, their wages are much higher than average for Chile, where 25% of the work force is idle.

In 1983, while the North American mining industry was deep in the red, CODELCO netted a respectable \$220.6 million on sales of \$1.8 billion. This year, in spite of severely depressed copper prices, it is expected to earn \$140 million. Profits would be even higher were it not for a government decree that diverts 10% of copper rev-

enues to the Chilean armed forces.

As U.S. copper producers see it, CODELCO's success comes mainly at their expense. Last year the company shipped a record 330,000 tons to the U.S.—46% of copper imports and 15% of all the copper used by U.S. manufacturers. Clearly, the strong dollar was a factor. But U.S. companies say CODELCO's refusal to scale back despite bulging world inventories is the prime reason world copper prices are so low. While U.S. mines are typically operating at 40% of capacity, CODELCO continues to run flat out. Douglas J. Bourne, chairman of Duval Corp., Pennzoil Co.'s mining subsidiary, charges that this is a deliberate attempt to drive U.S. companies out of the business.

RADICAL BREAK? CODELCO officials respond that their operation is the chief prop under a teetering economy. Chile depends on CODELCO for 46% of its foreign exchange. The government's 1983 interest payments on \$20 billion in debts consumed all of the \$678.5 million the company handed over to the state in taxes that year. Chile's military strongman, Augusto Pinochet, is likely to impose additional unpopular austerity measures to maintain debt payments, so the pressure will remain on CODELCO to keep production and ex-

ports high. The company is authorized to spend \$1.4 billion by 1986 to expand its mines. Outsiders estimate that by 1990 it could be mining 40% more copper than the 1.1 million tons it now produces a year.

Simon D. Straus, a former Asarco Inc. vice-chairman who is now a consultant, concedes that the Chilean government has monumental problems. But he believes that both CODELCO and Chile would be better off in the long run if they cut copper production to raise prices. That would ultimately bring in more foreign revenue, he says, while slowing the depletion of Chile's most important resource.

Chilean officials point out that for such a strategy to work, CODELCO would have to move in concert with other Third World producers, who are also spewing out copper at an accelerating rate. Given the developing world's plight, such cooperation is questionable. And that sort of planning would mark a radical break with Santiago's 11-year reliance on the free market. Some CODELCO executives even argue that copper's reign as a key metal is limited, so Chile should sell all it can before the market shrinks.

By John O'Brien in Santiago and Patrick Houston in Toronto

Cover Story

less than this year's Brazilian price of \$17 per dry metric ton, and that will pressure U.S. producers to make even more drastic cost cuts. Says Robert McInnes, president of Cleveland's Pickands Mather & Co.: "Importation of subsidized or low-cost foreign ore is, without question, one of the gravest threats our industry faces." Equally ominous, the cheap Carajas ore will cut the pro-

duction costs of some foreign-made steel, which already claims more than 20% of the U.S. market.

The Carajas mine project particularly galls U.S. executives because its \$5.1 billion price tag was underwritten with a \$500 million loan from the World Bank. "The world did not need Carajas," snaps Hanna Chairman Robert F. Anderson. Adds S.K. Scovil, chairman of Cleve-

land-Cliffs Iron Co.: "It was unconscionable [that] they made that loan."

Given so many adverse forces, it seems only a matter of time before the North American metals mining industry suffers a major casualty. Analysts contend that Phelps Dodge Corp., the second-largest U.S. copper producer, is especially vulnerable because it relies on copper for almost all its revenues. The

THERE'S NOT MUCH JOY IN LEADVILLE

For more than a century, Leadville, Colo., has mirrored the ups and downs of the mining industry. The town, then called Oro City, was devastated in 1865 when its gold mines played out. Twenty-eight years later, it was racked by the great silver crash, which turned local kings into paupers overnight. Now molybdenum has dealt Leadville a cruel blow.

Four years ago, Amax Inc.'s Climax mine employed 3,000 and had a payroll of more than \$80 million. Then demand for molybdenum plummeted. Amax closed the mine, and Leadville's unemployment rate leaped to 40%. Although Climax has since reopened with some 800 employees, the company has made it plain that the mine will never again employ thousands.

So residents of historic Leadville are now courting tourists and small businesses. This, the town hopes, will open up 2,500 jobs in 5 to 10 years. If it does, Leadville could provide a prototype for other withering mining towns. **BAWDY HOUSES.** Leadville has a wealth of Old West lore. Molly Brown got rich on its gold; Oscar Wilde outdrank the miners at a local silver mine. Once known as "the wickedest town in the West" because of the bawdy houses that lined Stillborn Alley, it still boasts unspoiled gingerbread cottages and Victorian commercial buildings.

After Amax shut down Climax, Leadville hired a full-timer to head its Chamber of Commerce, launched a series of summer events that included gold panning and a 100-mi. ultramarathon along the Continental Divide, and invested \$40,000 in a multimedia presentation ballyhooing its assets. By yearend the town will have spent \$100,000 marketing itself, and its merchants have approved a \$900,000 bond to upgrade the sidewalks and lighting.

As a result, says Elaine Kochevar, executive director of the Chamber of Commerce, tourism jumped 75% last summer, and revenues from the local sales tax rose nearly 25%. She expects



THE TOWN—BETRAYED BY GOLD, SILVER, AND MOLYBDENUM—IS TURNING TO TOURISM

more of the same this winter. With an \$850,000 grant from the state, Leadville's ski area, Ski Cooper, has expanded. This year it will offer lift tickets at \$12 a day—half the price at nearby Vail. Visitors are invariably reminded that a three-bedroom house in Leadville—just two hours from Denver—typically costs \$45,000, a fraction of the price at other Colorado ski resorts.

Big investors have taken notice. Dallas' Trace Investment Inc. plans to purchase six buildings, including the 1885 Vendome Hotel, where President Benjamin Harrison once trod a lobby floor inlaid with silver dollars. The company will pay about \$1.5 million for all six buildings and intends to spend \$10 million restoring and converting them to modern hotels or condominiums.

Revvng up tourism may prove easier, however, than attracting new businesses. One reason: Two-mile-high Leadville, situated just below the timberline, seems desolate to many outsiders. Winters are so long that the locals quip that Leadville has only two seasons—this winter and last.

The days are gone in Leadville when

the Guggenheims could build a fortune starting with one small smelter, or a David May could launch a nationwide department-store chain. "We're not going to land a Sperry Rand," admits Kochevar. Still, she adds, small manufacturers and distributors could be drawn to Leadville, with its ready labor and easy access to a railroad, airport, and interstate highway.

MELTDOWN. Eight new enterprises have started up in the past two years. To draw still more, the town has formed the Leadville Improvement Group with \$50,000 in state assistance. This office is now applying for a \$250,000 grant from the U.S. Housing & Urban Development Dept. To be matched by local banks, the money would finance low-cost loans to new businesses.

Compared with some previous schemes for reviving Leadville, the current plan looks eminently workable. Following the depression of 1893, for example, the town built a three-acre ice palace, complete with ballroom. It did a booming business—until a warm spell began melting its ice blocks.

By Sandra Atchison in Denver

Cover Story

company has lost \$187 million since 1982, and "unless the world copper price improves very sharply throughout the rest of the decade, it is difficult to see how the company can survive," says William G. Siedenbarg, an analyst with Smith Barney, Harris Upham & Co.

GETTING TOUGH. The day of reckoning also may be nearing for Kennecott, the copper mining giant acquired by Standard Oil Co. (Ohio) three years ago for \$1.8 billion. Sohio has been mulling over a proposed \$1 billion modernization for Kennecott's huge Bingham Canyon mine in Utah but has not approved the expenditure. That mine "is not something you'd lightly turn your back on," says Sohio Chairman Alton W. Whitehouse Jr. "But we just aren't going to take [Kennecott's] losses indefinitely."

As Big Oil backs out of metals mining, the independents are struggling to survive. While some are closing down high-cost operations, others can't even find the money to meet the steep severance and shutdown costs without eating into the cash they need to pay their debts. Corporate staffs are being cut. Falconbridge Ltd., a Canadian nickel producer, has slashed white-collar employment so much that top management now occupies one floor instead of three in its Toronto headquarters. Chairman William James even shares a secretary.

Mining companies are also getting tough with their unions. The most dramatic example is Phelps Dodge, which in July, 1983, accepted a strike at its Arizona mines and smelters rather than settle for the terms other copper producers agreed to. The company has replaced the strikers with nonunion workers and now awaits court rulings on decertification votes. In October, Pennzoil's Duval subsidiary unilaterally imposed a new labor contract on workers at its Sierrita (Ariz.) mine, cutting wages 15%, dropping cost-of-living adjustments, and increasing work time for all employees by two shifts a month.

These cost-cutting measures have resulted in impressive productivity gains. The cost of producing copper in the U.S. has dropped 25% in the past three years. Inco has lowered its breakeven point for nickel 12% this year alone, to \$2.30 a lb., and Chairman Baird's goal is to get down to \$2 next year.

NO FAT. More gains are needed. "We've reduced costs, but not at the same precipitous rates as metals prices have declined," says Kennecott President G. Frank Joklik. But making further headway will be tough. "The mining companies don't have any more fat to shave off," says Canadian consultant Felske.

Because they see diversification as a way out of their troubles, some base-

metals mining companies are rushing into gold—so many, in fact, that North American gold production is expected to jump 50% by 1989. "The only thing worth developing now is a good-grade precious metals deposit," says Alfred Powis, chairman of Noranda. His company is spending \$230 million to develop its Hemlo stake in Northern Ontario, a gold vein that eventually could add \$38 million to the company's annual profits.

Other companies are looking further afield. Newmont Mining Corp. intends to add a "fourth leg" to its copper, gold, and energy businesses, says Chairman Plato Malozemoff. Hanna is on the diversification trail too, but it will be cautious: It has been burned by bad moves in the past. Some 85% of its \$28.8 million loss last year resulted from energy businesses it acquired in the late 1970s.

Amax, which had eight separate metals divisions, is restructuring all its min-

slowly, because of what some see as an anomaly in the thinking of many metals mining executives. While they are rarely averse to the risks of developing new ore deposits, that same spirit usually does not extend into the marketing and financial aspects of their business. "The industry is dominated by guys who bring things to the surface," says consultant Felske. "They have to become more sophisticated in the commercial side of the business."

REDEMPTION? Some believe that redemption may be found in high technology. The Colorado School of Mines has launched what could become a \$25 million research effort to adapt automated factory techniques to mining. In October, Inco created a separate equipment company to develop machinery for continuously mining and transporting ore, now done in batches. But the potential of such innovations is limited. Concludes

THE SAD STATE OF METALS MINING

Composite figures for 10 leading independent metals mining companies: Amax, Asarco, Cleveland-Cliffs, Cominco, Falconbridge, Hanna, Inco, Newmont, Noranda, and Phelps Dodge

	1979	1980	1981	1982	1983
Millions of dollars					
NET EARNINGS	\$1,770	\$1,872	\$539	\$ -963	\$ -778
TOTAL DEBT	5,086	5,814	6,773	7,876	7,744
Percent					
DEBT AS A PERCENT OF CAPITALIZATION	34%	34%	36%	42%	43%
RETURN ON EQUITY	18	16	5	-9	-8

DATA: COMPANY FINANCIAL REPORTS

ing operations to make them more market-responsive. The company also wants to expand into more specialized products such as molybdenum chemicals, ceramics, and plastic composites. "That's the only way," says Chester O. Ensign Jr., who heads the company's strategic planning and development group, "to make sure Amax doesn't perish."

Consultants agree such changes are necessary. "Metals companies have got to become more market-driven," says Frank Schwab Jr., president of Fenves & Schwab Inc., a management consulting firm in New York. He also urges companies to get more involved in commodities trading to help offset the volatility of their business. Finally, Schwab advises his North American clients to enter joint ventures, especially with foreign partners. "Somehow," he says, "our companies have to develop a workable program to finance the development of ore reserves outside the U.S."

Here and there, mining companies are beginning to embrace such strategies. But even insiders acknowledge that the industry as a whole is changing too

Noranda Chairman Powis: "There's not going to be one technology that will change the economics of this industry."

The chance of getting much government help is dim. Mining companies lack political clout because their constituency is relatively small and they have been unable to put together a unified lobby. Moreover, a growing chorus of voices argues that a shortfall in U.S. metals production is not necessarily a problem. After all, notes John A. Cordes, head of the Mineral Economics Dept. at the Colorado School of Mines, "countries like Japan and West Germany have very, very strong economies with very low levels of metals self-sufficiency."

The U.S. is rapidly heading in their direction. Indeed, if another broad-based recession were to hit the U.S. in 1985 or 1986, it would probably sound the death knell for an industry that is already permanently bedridden.

By Patrick Houston in Toronto, Zachary Schiller in Cleveland, Sandra D. Atchison in Denver, Mark Crawford in Washington, James R. Norman in Houston, and Jeffrey Ryser in São Paulo

Dr. STRAUSS. That's it. Senator Domenici made a statement early this year in the Congressional Record which refers to the danger of losing 75 percent of our copper production capacity; 40 to 50 percent of iron; 90 percent of potash. These are only three out of many minerals. I won't elaborate on that, but if you have questions I will be glad to refer to them.

The figures cited in my statement indicate that U.S. metals mining—that doesn't include nonmetallic minerals and the fuel minerals—but simply the metals mining business was about a \$9 billion enterprise as recently as 1981. In 1983, according to the bureau's figures, it had dropped below \$6 billion. The number of jobs had been cut about in half.

In this condition, what can the industry say to the Congress and the administration about its role? The question of national security is more important than the fate of the mining industry. In a lot of quarters there is a statement that some of our industrial competitors get along without substantial mining industries and that is true. But, those countries are also in the posture of getting along without an adequate defense structure. They're counting on the United States to help them in regard to defense. In just the same way, when it comes to minerals availability in the event of adverse military or political developments, we can be sure that Japan and Western Europe would look to the stockpiles which the U.S. Government has as being equally accessible to them as to U.S. industry. I recall that during the Korean war, the then head of the British Government made a special trip to Washington to talk to President Truman and ask him for release of zinc from the national stockpile because the British position in respect to zinc was so deplorable.

So, this is the broad picture. The specific issue before you, the budget of the U.S. Bureau of Mines, I thought you very adroitly characterized Mr. Horton's unfortunate position in that he has to be a loyal employee of the Interior Department and has to support a budget cut which, in the opinion of our industry, has been assessed a 30-percent cut in his funds.

The loss of the research capacities of the Bureau of Mines can have a severe impact on our industry. In the sense that certain types of research are logically the purview of Government rather than of private industry—private industry does spend money on research and development, but that money is of a specific and concrete nature whereas the research undertaken by the Bureau of Mines and by the academic institutions is basic research of a kind which the companies themselves do not fund.

The institutes to which you referred—there are 31 of them, I believe—have done a good job of not only studying specific problems, but also of acquainting members of the faculty and students with the problems of the mining industry. Certainly there are unemployed mining engineers, process engineers, and geologists today but presumably those unemployed people are mortal. We cannot afford in an industry that is as basic as mining to have complete absence of new people coming along to replace the people who are operating the industry today. It is essential that the mining schools in our universities continue to train new people who will bring new ideas and new enthusiasm to the problems of the industry.

The institutes have been an excellent vehicle for doing that. Mr. Horton suggested that the institutes should be supported by private industry and by the various State organizations and I think it is quite true that both private industry and the State organizations are prepared to put up matching funds. The funds that have been made available to the institutes over recent years by the actions of Congress really provide the seed money. If I were sitting on the board of directors of a mining company and asked to put up money for a minerals institute and learn that the U.S. Government had withdrawn its financial support from that institute, I would question whether it was an appropriate objective for my company to continue to support it. I think the significance of support by the Federal Government will mean that anywhere from twice to five times as much money will be made available to these institutes from other sources. If the Federal funds are withdrawn, I suspect the amount of money available from other sources will also tend to diminish.

Well, Mr. Chairman, I've sort of rambled on here. I'd be glad to answer questions. As you've indicated, my statement as a whole is going to be part of the record. The Bureau of Mines is one of the truly professional organizations of the U.S. Government and I would hope that the Congress will see fit to make certain that its appropriation is on a more generous basis than the President's proposal.

[The prepared statement of Dr. Strauss follows:]



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Statement Of

AMERICAN MINING CONGRESS

by

SIMON D. STRAUSS

Consultant

Before the

Subcommittee on Transportation, Aviation and Materials

of the

Committee on Science and Technology

U.S. House of Representatives

Washington, D.C.

April 24, 1985

Mr. Chairman and Members of the Subcommittee:

I would like to thank the Subcommittee for the opportunity to comment on the role of the Bureau of Mines with respect to those activities that fall under the aegis of this Committee and upon Fiscal Year 1986 budget requests of the Bureau of Mines.

I am testifying on behalf of the American Mining Congress. I am Simon D. Strauss, immediate past Chairman of its Minerals Availability Committee and Consultant on mineral policy problems to the American Mining Congress and the industry.

The American Mining Congress is an industry association that encompasses: (1) producers of most of America's metals, coal and industrial and agricultural minerals; (2) manufacturers of mining and mineral processing machinery, equipment and supplies; and (3) engineering and consulting firms and financial institutions that serve the mining industry.

Before directly discussing the program activities of the Bureau of Mines and so that this Subcommittee can more clearly understand the reasons for our comments, I feel it necessary to review briefly the economic condition of the mining industry and its effect upon the national security and economic well-being of the Nation.

ECONOMIC CONDITION OF THE MINING INDUSTRY

The economic state of the mining industry has become front-page news. The cover story of the December 17, 1984, issue

of Business Week aptly stated that the recovery of 1983-84 largely bypassed producers of copper, iron ore, nickel, lead, zinc and molybdenum. Senator Domenici, in his excellent statement in the January 22, 1985, Congressional Record, points out that the United States is in danger of losing 75 percent of its copper industry, 40 to 50 percent of its iron-ore industry, and that 90 percent of the U.S. potash industry is in peril.

Certainly, these trends are of vital concern to the mining and mineral processing industries in the United States. But more importantly, they impact dangerously upon the national security and economic well-being individually of each citizen and corporately upon the nation.

From a national security standpoint, unless positive actions are undertaken by government, the country faces a devastating minerals crisis. The United States has become increasingly dependent on foreign sources for many strategic minerals, base metals and industrial materials that are essential to the nation's security and industrial base. Some of these foreign sources are countries subject to economic, social and political instability. Many are located at the far end of vulnerable shipping lanes. These factors make this nation liable to cut-offs of supply and to gyrations of price.

A few facts and figures illustrate the effect of reduced mineral production upon our national well-being. In 1981, U.S. metals mining was an \$8.9 billion enterprise. By 1983, it had shrunk to just \$5.9 billion. The jobs provided exceeded 109,000

in 1981. At the beginning of 1985, what remains is a workforce of about 44,800. And the prognosis is for further reduction.

The Committee will recognize the parallel between the difficulties facing the mining industry and the current plight of the Nation's farmers, a subject intensely discussed in the Halls of Congress in recent weeks. The farmers and miners of this country are the source of the basic materials for all economic activity.

THE CURRENT SITUATION

Current activity in the field of mineral and materials research and development is carried out by a large number of professional organizations, universities, industrial groups, and governmental agencies.

Rather than research and development per se, the professional societies serve a very necessary role in the dissemination of research and development information. The Bureau of Mines contributes heavily to this effort. For example, in FY 1984 Bureau of Mines personnel authored or coauthored 339 scientific treatises at professional society meetings, symposia, and other scientific outlets sponsored by them.

Academic institutions conduct minerals and materials research from basic research through development to applications, both in extractive metallurgy technology, i.e. minerals processing, and materials and recycling technology, including improving service life and the performance of minerals. Accurate

dollar figures are not available, but later I will discuss the 31 Mining and Minerals Resources Research Institutes that play a major role in university research and development.

As one would expect, industrial research by the mining and metals industries concentrates on the application end of the R&D spectrum. It is, in many cases, process oriented and frequently occurs in conjunction with pilot-plant or full-scale operations.

The aggregate level of R&D by the mining and metals industry is not documented. If such figures were available for past years they would be misleading. The current financial state of the industry has caused company after company to eliminate or severely reduce its R&D efforts. R&D in these industries in many instances involves proprietary information. Individual companies are understandably reluctant to share R&D technology because of legal complications centering around anti-trust legislation.

In the federal government sector, the Bureau of Mines, along with the National Bureau of Standards, NASA, and National Science Foundation are the principal providers of materials research and technology. The National Bureau of Standards provides data, measurement methods, standards and reference materials, concepts, and technical information on the fundamental aspects of processing, structures, properties and performance of materials. NASA's research is formulated to further its mission in aeronautics science and space technology. The primary materials focus of the National Science Foundation is in solid

state and low temperatures physics, solid state chemistry, metallurgy, ceramics and polymers.

Thus, the Bureau of Mines is the single federal agency to which the mining and metals industry can turn for technological innovations that will help make it competitive in a world economy. The Bureau's role of improving fundamental knowledge of processes involved in the production and use of minerals, when applied to addressing national mineral supply issues, can be expressed in the following principal research goals:

- o to devise new and innovative extractive metallurgy methods for treating domestic low-grade and complex resources;
- o to seek substitute and alternative domestic minerals to lessen dependence on foreign sources;
- o to discover new technologies to conserve limited domestic resources through recycling.

The minerals and materials research program actively pursues all three goals primarily through fundamental, high-risk research.

Several examples illustrate the type of contributions that the Bureau has made recently to U.S. industry:

1. High Performance Corrosion Resistant Sulfur Concrete

A construction material, developed by the Bureau and already in commercial production, based on plasticized sulfur and mineral aggregate, is superior in corrosion resistance and

strength to portland cement concrete. The material can be used in the chemical, metallurgical, and fertilizer industries, and will also provide an attractive market for by-product sulfur resulting from compliance with pollution regulations.

There is also the possibility that sulfur concrete could be used in naval port facilities and bridge decking applications to prevent salt deterioration and to prolong their effective lives. It has been estimated that bridge decking damage due to salt deterioration alone constitutes a remedial repair cost of \$24,000,000,000 within the United States. Questions related to thermal cracking and corrosion are in need of investigation before this use can be established.

2. Increased Recovery from Western Phosphates

The Bureau of Mines has developed a method for recovering commercial phosphate from a wide variety of complex western phosphate materials, including low-grade ores, tailings, and unused fines.

Adoption of the new flotation technology, if successful, would allow a 16 percent reduction in the amount of ore and overburden being mined. Also, lower quality materials currently mined and stockpiled during the mining of high-grade ore could be used.

The flotation technique provides a higher-purity phosphate. This concentrate allows greater flexibility and more positive control over product grade.

3. Soft Soldering of Aluminum

Aluminum and its alloys are fabricated into items such as radiators, heat exchangers, and other fixtures by exotic brazing techniques that are complex and costly. After fabrication, if the item breaks, no practical soldering system has been available to repair it. Most broken items are therefore discarded. A system of fabrication and repair has been needed to permit the use of standard tin-lead "soft" soldering systems for widely used aluminum and aluminum alloys. Such a system has now been devised by the Bureau of Mines.

Assuming 80 percent of radiators will be made of aluminum and a one percent failure rate per year, savings from this technology are estimated to approximate \$8-10 million per year.

MINERAL INSTITUTES

The 31 mineral institutes, located in as many states, matched with nonfederal funds, participate in basic research and training in mineral-related graduate programs. As in several previous years, the 1986 Administration budget has requested no funding for this program, a program that Congress reauthorized in 1984 for five years.

I call the Subcommittee's attention to the report of five years of achievements by the Mining and Minerals Resource Research Institutes printed by the American Mining Congress. This report contains many examples of accomplishments of this program.

In addition to supporting an average of 320 undergraduate and 520 graduate students each year, over 100 final research reports have been made public through the Institutes. These students, with training in applications of high-technology, will play a vital role in making U.S. mining and metals industries competitive in present and future markets.

Three examples of Institute research projects are:

1. West Virginia University, Roof Control Criteria for Longwall Mining

Analyzes the effects of strata behavior in terms of the forces present in coal mines of various depths and under various geological conditions. This enables long wall coal mines to be effectively laid out so that they will be both highly productive and safe for miners to work in.

2. University of Arizona Smelter Emission Controls

Analyzes the effect of compliance strategies for SO² emission control on the economies of copper and other nonferrous smelters. Special attention is devoted to the costs of transporting concentrates to smelters and the costs of getting rid of by-product acid. Pricing practices are analyzed with respect to industry structure, competitiveness, solvency, and possible response to Federal Aid.

3. Pennsylvania State University Manufacture of Improved Refractories

Describes the development of a process that may permit certain refractories, which are needed in the preparation of molten metals, to be produced directly and in a less expensive manner and from readily available materials.

COOPERATIVE RESEARCH

For a briefing in one area of cooperative materials research among industry, government, universities, and professional societies, I would refer you to the publication on steel related products by the American Iron and Steel Institute (AISI) entitled "Research 1984-85."

To cite but several examples:

1. Fundamentals of Stainless Pickling

The acid pickling of stainless steel is being studied to determine the effects of pickling bath variables on the removal of scale and the pickled stainless steel surface. This information will be used to optimize the pickling process, extend bath life, and reduce the volume of waste solution for disposal. This project is being undertaken by the Bureau of Mines in conjunction with the AISI.

2. Foundry Charge Materials Chemistry

Forty foundries are cooperating through the American Foundrymen's Society with the Bureau of Mines to establish a data base on 29 residual elements in iron castings for the purpose of establishing changes in the quality of ferrous scrap and how

these trends affect foundry practice and the chemistry of castings produced.

3. Arc Stability in Electric Steelmaking Furnaces

This project involves installation of instrumentation and a series of full scale trials at the Contrecoeur steel plant of Sidbec-Dosco Inc. For steelmakers, the direct and indirect results of modified procedures will be to reduce production costs, to decrease noise levels in existing facilities and to avoid certain capital costs. Electric power utilities will benefit from reduction of voltage fluctuations that otherwise requires costly control equipment to avoid interference with other customers. The project is being co-sponsored by the Electric Power Research Institute (EPRI) and 20 member companies of AISI and managed through the Metals Production Center of Mellon Institute.

4. Induction Heating for Semifinished Products

With increasing interest in direct rolling and the potential for using induction heating to achieve the "hot connection," the EPRI-AISI interaction task force established in 1982 assigned a high priority (second only to arc stability studies) to induction heating studies.

In the fall of 1983, a collaborative program was initiated at McLouth Steel Products Corporation involving EPRI, AJAX, Detroit Edison and Batelle. This program includes slab temperature measurement, comprehensive data collection on all

aspects of power consumption, economic analysis of slab "hot storage" and computerized process control. The feasibility for a reheat setup for strip prior to its entry into a six stand rolling mill is also a candidate for study.

5. Basic Research on Steelmaking Refractories

Recognizing the need to maintain university research activity on iron and steelmaking refractories, refractory companies are now jointly sponsoring university research projects with the AISI. This program also fosters productive interchange and interaction between professors, students, and representatives of both industries.

THE DESIRED SITUATION

Although research and development cannot be neatly categorized into areas of responsibility by academic institutions, the Bureau of Mines, and industry, we think a general role model, differing somewhat from the current one, would better serve national needs. We visualize this model as being composed of the following elements:

1. Academic institutions concentrate on basic research.
2. Industrial R&D concentrate at the application end of the continuum.
3. The Bureau of Mines concentrate on developmental research, i.e. the so necessary linkage between basic research and application phases, with basic or fundamental high-risk

research programmed only where skills and facilities clearly point to the Bureau as the optimal research institution.

We think that such a model would best utilize the strengths in skills and facilities of the various research groups and help maximize the R&D results for the national security and economic well-being of our Nation. In particular, the Bureau of Mines has ably demonstrated its capacity to (1) identify basic research results that have a high potential for future application; (2) plan and accomplish the developmental research necessary to ready processes for pilot plant testing, and (3) present the data to industry in such a manner that industry can carry through to operational techniques, either alone or with the cooperation of the Bureau.

THE NEED

We have attempted to show the precarious economics situation of the mining and metals industry and its importance to the national security and economic well-being of our Nation. These capital intensive industries burdened with millions of dollars of expenditures in environmental costs, competition from governmentally subsidized production in third world countries, and, in many cases, a negative cash flow are literally fighting for their survival.

In that climate, the United States can ill afford to cut off one of the few remaining legs supporting our basic mining and metals industries, i.e. the programs of the Bureau of Mines in minerals and materials research and the mineral institutes.

In the past few weeks, substantial closures of U.S. mining and refining capacities have occurred, thus further weakening industry's R&D capacity. We strongly urge that your Committee recommend FY 1986 funding for minerals and materials research by the U.S. Bureau of Mines at the FY 1985 level of \$32,761,000, along with the FY 1985 Full Time Employment personnel ceiling.

With reference to funding of the mineral research institutes, we strongly urge that your Committee recommend funding at the current level of authorization, \$24,400,000.

I appreciate the opportunity to appear before this committee and express the views of the American Mining Congress. I would be glad to answer questions you may have.

Mr. REID. Dr. Strauss, I appreciate your being as candid as you have been. In looking at your statement, I see one sentence that I would like to draw your attention to; "The Bureau of Mines is a single Federal agency to which the mining and metals industry can turn for technological innovations that will help make it competitive in a world economy." Would you elaborate on that statement?

Dr. STRAUSS. Well, yes. The higher wage scales, the strength of the dollar, and the low grade of the ores that the United States is currently mining all combine to create handicaps of cost for the domestic producers in relation to their overseas competitors. As an example, I know Dr. Maxwell is very familiar with this question. The average grade of copper ore mined in the United States is currently just a little over one half percent; in other words, about 10 pounds of copper per short ton of ore mined. The average grade in Chile, which is today the largest producer of copper in the world—that happened in 1982 that Chilean production surpassed U.S. production—in the case of Chile, the average grade is about 1.4 percent, or about 28 pounds of copper recovered per ton of ore mined. So, the Chileans start off with almost three times as much copper in their ore as the U.S. mines do.

In addition to that, the Chileans have the advantage of a much lower wage scale than the U.S. mines and that difference has been exacerbated by the strength of the dollar or the weakness of the Chilean peso, whichever way you want to put it. The relationship today is very different than it was 3 or 4 years ago.

What to do about that? Well, what you have to try to do about that is to work out technology which will reduce your labor input in order to compensate for the lower grade of ore mined. The Bureau of Mines has carried on research both on the mining side and on the processing side directed to these very issues. We would be sorry to see those efforts reduced. Right now, there is a great deal of interest, for example, in the recovery of copper from ore through leaching methods rather than through the traditional milling and smelting procedures because it impinges less heavily on the environment and because it means less energy input and the hope of lower costs.

The Bureau of Mines has done very valuable work in that respect.

Mr. REID. It would seem to me that when we have a real problem as we now have and science is advancing so rapidly in all fields that we're really doing ourselves a disservice by not having the modern scientists, if you will, looking into these problems which the older scientists, mining engineers, geologists, et cetera, would not have the opportunity to even learn in school. Is that right?

Dr. STRAUSS. That's quite correct. Within the last 2 or 3 years, for example, there is a good deal of interest being shown in the use of bacteria which are organic for treating of ores which are inorganic. Whether or not this will be a successful procedure, we don't know. It's the kind of research into which an organization like the Bureau of Mines can devote attention in which the individual mining company is reluctant to do because of the proprietary problems if they invest a lot of money. If they do this, they will be benefiting their competitors as well as themselves.

Mr. REID. Dr. Strauss, one last question. You also have a sentence in your statement that the 31 minerals institutes located in many States matched with non-Federal dollars and Federal dollars, participate in basic research and training in mineral related graduate programs. My point is that it seems to me that what we have here when we're having a cutback is like a business that's in a recession. The first thing they cut back on is advertising when they need it more at that time than any other time. It seems that's what we're doing here. We're in effect being penny wise and pound foolish. We have a minerals industry that's in deep trouble. The copper industry is a good example. When we have to become more competitive through the thing that the United States has always done better—that is, technology—it seems that we're really biting off our nose to spite our face. Would you agree?

Dr. STRAUSS. I entirely agree with that. In fact, as I said before, the thought that, well, because we've got unemployment among mining engineers and process engineers and geologists, we don't need to train new ones, is flying in the face of experience. The mining engineers and metallurgists and geologists are not going to live forever. We're going to have to have new ones. If you shut down the mining schools, you're not going to be able suddenly to re-create them. You've got to have continuity.

Mr. REID. You mention that 90 percent of the U.S. potash industry is in trouble. Tell me what you mean by that.

Dr. STRAUSS. The major source of potash in the United States has been the mines in New Mexico. Most of these are either in the process of closing or have already closed.

Mr. REID. Why?

Dr. STRAUSS. Well, because of the fact that there is lower cost production in Canada and some of the overseas countries.

Mr. REID. Why is potash important?

Dr. STRAUSS. Potash is one of the three basic agricultural minerals for fertilizer.

Mr. REID. Mr. Lewis.

Mr. LEWIS. Thank you, Mr. Chairman. Dr. Strauss, Mr. Horton mentioned the mining industry does not want any subsidies. What do you say about that?

Dr. STRAUSS. I agree. The mining industry has never sought an outright cash payment for its production comparable to some of the programs that have existed in the agricultural field. What the mining industry has tried to say to the Government is that we need to have enough Government support so that we can continue to exist. Without support either in the form of quotas or production restraint—the difficulties in the copper industry are not the result of poor consumption of copper. It may surprise you to know that 1984 saw the second highest consumption of copper in the history of the Western World.

The difficulty arose from the fact that production on the part of the developing countries had been maintained during the recession years of 1981, 1982, and 1983. Very large inventories had been built up. The existence of those inventories acted as a depressant on the price of copper so that the price of copper in 1984—in spite of the worldwide recovery and consumption—remained depressed. In the case of the dollar price, it was actually down. To illustrate this

point about the strength of the dollar versus other currencies, expressed in British pounds, the price of copper in 1984 was higher than it was in 1983. Certainly expressed in currencies like those of Peru, Chile, Zambia, and Zaire—the four principal copper producers in the developing world—the price was quite satisfactory from their standpoint.

The U.S. producer was being hurt because, in terms of his currency and his costs, the price was down. For the other producers, the price was up. The result was that they maintained a high level of production and the heavy stocks that they had helped to create in the previous years were overhanging the market. So the U.S. industry went to the U.S. Government and said that they should suggest to these people that they do something in the way of restraint—not shutting down production—nobody has suggested that. A modest curtailment of perhaps 5 or 10 percent from their then existing levels of production would have resulted in substantial price improvement and would have helped the domestic industry to survive.

If I can draw a parallel, this is very similar to many of the agricultural programs where our Government, looking at its own industry, has actually asked people to refrain from producing. The administration has been unwilling to do that and has—in spite of the fact that Congress in the Trade Act of 1984 actually recommended that such representations be made.

Mr. LEWIS. I'm not really sure if you're for or against subsidies or what.

Dr. STRAUSS. I'm against subsidies but I am in favor, Mr. Lewis, of a program of survival for the industry not through cash payments of any kind.

Mr. LEWIS. Do you have any recommendations for that program?

Dr. STRAUSS. Yes, my recommendation for that program is that the U.S. Government make clear, as Congressman Udall and Senator Deconcini and Senator Domenici have indicated in the legislation they have proposed, that the U.S. Government seek a worldwide understanding with respect to the levels of production. My colleague, Mr. Overton, points out to me and I failed to stress in this discussion of the problem of the copper industry, the fact that much of the production of copper outside the United States is in the hands of public sector companies. The Chilean production is largely in the hands of a corporation owned outright by the Chilean Government.

Their standards for operation are very different from private sector companies such as operate in the U.S. copper industry. They are trying to maximize employment and maximize foreign exchange earnings and that is their excuse for maintaining production, even in the face of falling demand as occurred in 1981, 1982, and 1983.

Mr. LEWIS. I'm glad that he pointed that out because what you were saying about copper certainly was a little bit different from some of the things that I've been reading.

How much copper mining do we have going on right now in the United States?

Dr. STRAUSS. The present rate of copper production in the United States is about a million to a million, one hundred thousand short

tons a year. Our peak production was in 1973 and again in 1979 at about a million seven hundred thousand. So, we are running at less than two-thirds of our peak production.

Mr. LEWIS. Do you have any idea how many mines we have shut down in the past 5 years?

Dr. STRAUSS. Several mines have shut down and reopened and other mines have since shut down. Of the 25 major mines as listed by the Bureau of Mines, at one time or another 16 have been closed.

Mr. LEWIS. What mines do we have that are the major producers of copper?

Dr. STRAUSS. The largest copper producers currently operating are the Chino mine of Kennecott in New Mexico; in Arizona you have Raye which is Kennecott, San Manuel and the Morensi which is Phelps Dodge. I overlooked the Tyrone mine of Phelps Dodge which is operating in New Mexico. In Utah, the large mine of Bingham has been closed. In Nevada, there are no currently running mines. The Serita and Mission are two other large mines in Arizona. There's a modest sized mine in Montana, the Troy mine which was a fairly new mine brought in by Asarco. That's about the list of the presently producing substantial mines in the country.

Mr. LEWIS. Who is our greatest competitor?

Dr. STRAUSS. Chile.

Mr. LEWIS. I would like to get off copper for a moment and talk about sulfur concretes. You made mention in your presentation that \$24 billion worth of bridge decking that needs repair. Is the industry making use of this material now and what needs to be done?

Dr. STRAUSS. It's still largely in the experimental stage because State governments and local governments that do most of the road work are reluctant to try a new material until it's been thoroughly proven. The Sulfur Institute, which is a private organization, and the Bureau of Mines are carrying on this program in detail and it does seem to offer a very considerable possibility. Certainly if it works well, considering what is spent now in rehabilitation of our road and highway system, it's something that should be actively pursued.

Mr. Overton pointed out that my statement with respect to Chile being our principal competitor was, of course, in regard to copper.

Mr. REID. That was Mr. Lewis' question in reference to copper. Mr. Packard?

Mr. PACKARD. Thank you, Mr. Chairman. Dr. Strauss, let me pursue the gentleman from Florida's line of questions a little bit further. You mentioned that in the United States our production is somewhere between 1 and 1.5 million—

Dr. STRAUSS. One million and one million one hundred thousand.

Mr. PACKARD. All right, short tons of copper. What is the consumption of copper in the United States?

Dr. STRAUSS. In terms of refined copper—copper is a very complex industry because so much is recovered through recycling. Not all of the recycled copper becomes refined. In terms of refined copper—all the mine production has to be refined to start off with. Our present rate of consumption is about 2 million tons a year.

Mr. PACKARD. So, we're an importer?

Dr. STRAUSS. Part of the gap between the 1.1 and 2 million is filled by that share of the recycled copper that is refined which is maybe 200,000 or 300,000.

We're importing at the rate of perhaps 600,000 tons a year.

Mr. PACKARD. Are we exporting copper?

Dr. STRAUSS. A very small amount of copper is exported and the 600,000 ton figure is a net, namely the excess of imports over exports. It is something that, perhaps, very few people recall. It will interest you to know that in the 1920's, the United States was not only the largest consumer of copper and the largest producer of copper, it was also the largest net exporter. At that time the industry was smaller than it is today. The United States was then producing about a million tons of copper a year and exporting about 300,000. The consumption was only about 700,000.

Mr. PACKARD. Do we have a relatively unlimited supply of copper?

Dr. STRAUSS. Like all other mineral materials, it's finite. The amount of copper in the reserve in the United States, according to the statements of the Bureau of Mines, would be sufficient to maintain maximum production for something like 40 to 50 years. We're nowhere near exhausting our copper resources. Furthermore, in my opinion, we haven't identified all our potential resources.

In 1950 when President Truman set up the Paley Commission, there was an interesting study put out by the Paley Commission. You can look it up. In volume II of that report, talking about the copper industry, they then estimated that the United States would require 2 million tons of copper a year. But, they said, at best we cannot expect to produce more than 800,000 tons a year by the 1970's so we will be dependent on imports for 1.2 million. That estimate of 800,000 tons a year was based on the best judgment of people like the Geological Survey as to the copper resources of this country. Between 1950 and 1975, enough copper was found so that in 1973, as I've already said, our production was not 800,000 tons; it was 1.7 million tons.

I believe that this country has very large resources.

Mr. PACKARD. So, in your judgment, it's possible for the United States to produce as much as the United States would use?

Dr. STRAUSS. It could be done. Some of it would presumably be high cost and, therefore, you have this——

Mr. PACKARD. That's my next question. What's the cost per ton in the United States to produce?

Dr. STRAUSS. I indicated the number of mines. Each mine has a different cost. There is some production in the United States obtained by the leaching method I referred to earlier or as a byproduct in association with precious metals that probably costs under 50 cents a pound.

If you took an average, I think most students would say now the costs are somewhere between 70 and 80 cents a pound. Some of the mines that have been closed down in Montana and Michigan and elsewhere have costs as high as \$1 or \$1.10 per pound.

Mr. PACKARD. How competitive is that to import copper?

Dr. STRAUSS. Their costs are all over the map, too. The Chilean copper is estimated to cost about 50 cents a pound.

Mr. PACKARD. Delivered here?

Dr. STRAUSS. Yes.

Mr. PACKARD. So, it's a matter of competition more than it is a matter of production?

Dr. STRAUSS. Of resources, that's correct, particularly because of this factor that I mentioned earlier that the U.S. industry is in private hands. The foreign industry is in public hands. The copper producers in Central Africa are relatively high cost but they continue to operate anyway because their government won't let them close down. The governments own them.

Mr. PACKARD. One of your primary concerns is the reduction in budget allocations. If the industry sees a need for production controls and recommends Government controlling of production, what is to prevent the industry itself from imposing those kinds of controls upon themselves?

Dr. STRAUSS. If you're speaking of the United States, of course the antitrust law is the major consideration. The individual companies have each controlled their own production to the level of their demand, but they can't get together and make an agreement.

Mr. PACKARD. I understand that but I'm talking about—

Dr. STRAUSS. The domestic industry has cut back. Our problem is that our overseas competitors for what they consider to be logical reasons have not.

Mr. PACKARD. The Bureau of Mines has indicated that there are economic problems in the metal mining industry. Do you feel that that's where the primary problem is or is it almost equal across-the-board in the nonmetal?

Dr. STRAUSS. It depends on the material, sir. A large part of our nonmetallic mineral production is materials for the building industry: sand, gravel, stone and so forth. Very bulky materials with high transport costs. Those industries do not suffer from import competition simply because transport costs rule out the possibility. You get into the agricultural materials and the problem is similar. Coal has its own unique difficulties in relation to the competitive costs of other fuels.

Mr. PACKARD. Is the industry overregulated? Is that creating some problems as far as competition is concerned?

Dr. STRAUSS. I think the principal problem in competition that the industry has found has been—I want to be clear that I'm not criticizing the existence of environmental measures—the fact that environmental measures impinge heavily on the domestic industry and similar costs are not imposed on many of our overseas competitors, yes.

Mr. PACKARD. You don't even have to go overseas. I'm aware of some problems right at the Mexican border.

Dr. STRAUSS. Right, sir.

Mr. PACKARD. Dust and emission controls are severe in our own copper industry in southern Arizona and New Mexico and not so just across the border within eyevue of some of the Mexican plants. The dust and the debris blows across the border from their plants and pollutes the very air that our—

Dr. STRAUSS. It will amuse you to know that at least 12 years ago, on a visit I made to Mexico City, I met with a chap who was No. 2 in the equivalent of their Interior Department. He was talk-

ing—it was when the environmental constraints and the sulfuric acid emissions was a very lively topic of conversation in this country. He was aware of the fact that the Arizona copper smelting industry was facing problems because of the need for controlling sulfur emissions. He said to me what do you think of our government building a custom smelting plant close to the Arizona border which would be available for the treatment of concentrates from the Arizona mines? That was 12 years ago.

Mr. PACKARD. I've studied some articles on the problem down there and it's rather unique. They borrowed \$123 million through the International Bank and IMF to build their plant below the border and then they polluted the air that closed down some of our mines on our side of the border. It's a bizarre situation but nevertheless it does exist.

There's no question that there are serious problems in our domestic mining industry. What do you think aside from simply budgeting issues, what do you think the solution is? That's a broad question but I would like to hear some of your responses.

Dr. STRAUSS. I'm afraid in giving you an off the cuff response I might perhaps overlook some aspects. We have submitted statements previously with regard to taxation policy as well as trade policy on this matter. The best response I could give would be to have you take a look to the policy resolutions of the American Mining Congress which cover a whole range of areas in which we think Government action would be appropriate in this field.

Mr. PACKARD. Thank you very much.

Mr. OVERTON. Mr. Chairman, might I make a comment to Mr. Packard? He has asked a very important question.

Mr. REID. Yes, please do. You have to speak into your microphone.

Mr. OVERTON. We had about 300 chief and senior officers of the mining and minerals companies of this country addressing this precise question. Inspired by the fact that when you look across the board at the entire minerals base of the country, it is fair to say that it is the belief of these people that the minerals base and the minerals processing base of the United States is rapidly deteriorating. As we've said earlier, this not only adversely impacts our economic circumstance but, in their belief also, it is having a materially adverse impact of intolerable proportions on the national security posture of the country. What we would do, in response to your question, is to send you their answers. There were a whole series of modest tunings of Government policy clear across the boards that they felt would be helpful in trying to foster and promote the maintenance of a vigorous minerals and minerals processing industry in the United States.

This country is in real serious difficulty with regard to its minerals base and with regard to its minerals processing base.

Mr. REID. Mr. Overton, what we will do is we'll make those a part of this record. We would also ask that we be supplied with copies of those independently as subcommittee members.

Mr. OVERTON. Thank you.

Mr. REID. Thank you very much. We appreciate very much your time and effort here this morning. It's been most informative.

[Additional material for the record follows:]



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MINING
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May 7, 1985

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The Honorable Dan Glickman, Chairman
Subcommittee on Transportation, Aviation
and Materials
Committee on Science and Technology
U.S. House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman;

During the course of your subcommittee hearings on April 24, 1985, concerning the Bureau of Mines budget requests, we were asked to supply your subcommittee with the Declaration of Policy of the American Mining Congress for inclusion in the hearing record. This policy declaration is attached.

We were also asked to independently supply copies of this statement to subcommittee members. We have fulfilled this request under separate cover.

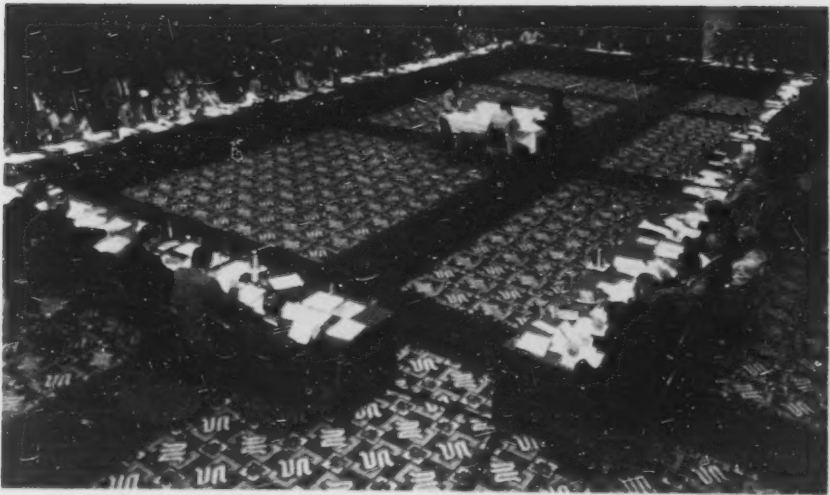
Again, we appreciated the opportunity to appear before your subcommittee and present our views at this oversight hearing.

Sincerely,

J. Allen Overton, Jr.
President

Enclosure

**AMERICAN
MINING
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JOURNAL**



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DECLARATION OF POLICY of the American Mining Congress

A strong domestic minerals base is essential to the national security and economic well-being of the United States, and the mining industry is committed to its development. This commitment can be met, however, only when several priority requirements are satisfied.

Access to Minerals

Minerals can be mined only where they are found, and geological evidence indicates there may be potential deposits on America's huge public lands. The extensive withdrawal of these lands from mineral exploration and development, therefore, inhibits expansion of the domestic mineral base.

There should be multiple use of public lands, including mining, which can and ought to be practiced to provide a balance of environmental responsibility and economic results.

The National Defense Stockpile should be prudently maintained for use in national emergencies, but it should not be employed to offset federal budget deficits.

Adequate Markets

Domestic mining is capital intensive and must compete in world markets. It can thrive only in a healthy world economy that stimulates broad needs for its production.

The U.S. Government should adhere to fiscal and monetary policies that support free markets and vigorous economic activity at home, while encouraging free-market policies and practices in other countries.

Fair Competition

The global economy, with its increasing inter-

dependence among nations, can thrive only in a climate of fair competition.

Foreign dumping of goods, direct subsidy of exports, unreasonable restrictions on return of capital, manipulation of currency exchange rates, and acts of price protection should be firmly resisted, because they give unnatural advantage to the favored competitors and aggravate U.S. balance-of-payments problems.

The United States should also oppose any bilateral or multilateral financial support that serves to promote uneconomic production and helps to initiate or expand projects for producing minerals that are already in oversupply worldwide.

Reasonable Earnings

The mining industry needs sufficient earnings to maintain a healthy financial condition to furnish the capital needed to replace depleted resources and modernize facilities, while permitting a reasonable return to the shareholders.

In imposing costs on the domestic industry by way of taxation or through environmental and other regulations, the U.S. Government should take into account costs elsewhere in the world where many mineral producers operate under less restrictive regulatory standards.

Although mining should pay its appropriate share of costs relating to the environment, safety, health and other important concerns of the American public, there should be a realistic balancing of costs and benefits that takes into account the need for economic growth.

Pete Malenecoff of Newmont offers the new policy introduction. Seated at right are Robert Muth of Asarco, chairman of the Resolutions Committee, and Ralph Bailey of Conoco, chairman of AMC.





T. S. Ary of Kerr-McGee presents the minerals availability plan.

AVAILABILITY OF MINERALS

MINERALS AVAILABILITY

On two significant occasions in recent memory the U.S. Congress affirmed it to be the national policy to foster private enterprise in developing a sound and economically viable domestic mining and minerals processing industry. This policy is expressed unequivocally in the Mining and Minerals Policy Act of 1970 and the Materials and Minerals Policy, Research and Development Act of 1980.

These affirmations of policy were echoed by President Reagan in 1982 when he sent to Congress his National Materials and Minerals Plan, which included this statement: "It is the policy of this Administration to decrease America's minerals vulnerability by taking positive action that will promote our national security, help ensure a healthy and vigorous economy, create American jobs, and protect America's natural resources and environment."

Causes of Decline

Despite these congressional and presidential expressions of sound objective and solid determination, little progress has been made to free the United States from its deteriorating position in global minerals trade and its increasing dependence on imports. The resulting vulnerability to foreign behavior is disturbing, indeed.

Among the major causes of America's present predicament regarding minerals are the growing geographic limits placed on exploration and mining (see Public

Lands section), the mounting costs of meeting rigid and costly environmental standards and others (see Environmental Quality section and Regulatory Reform section), and the disadvantages of trying to compete under unfair rules with foreign mineral producers (see Investment Climate and Trade Policy section).

Time to Implement Policy

The American Mining Congress strongly believes it is time—indeed, it is urgent—that the national policies enunciated by the U.S. Congress and the President be implemented forcefully by means of an Executive Order issued by the President. We have urged this in the past and repeat it now.

The fact is that the United States does not really have a true national minerals policy, and until one is both formulated and implemented, no pronouncements of good intentions can serve as a substitute.

Defense Stockpile

The National Defense Stockpile is an important element in minerals availability and national defense readiness, particularly in relation to certain critical metals for which the United States has a high degree of import dependence.

Nevertheless, in recent decades stockpile objectives for various metals have been subject to frequent and drastic swings that clearly were not determined by strategic considerations.

A national minerals policy should reflect experience

and provide for greater consistency of policy adherence to the national security aspects of its mission, for which the stockpile was authorized. For this reason, the American Mining Congress has suggested that responsibility for the stockpile be placed in an independent government corporation.

We also have supported legislation to establish stockpile objectives in relation to average imports over the previous five years of the mineral concerned. This would provide an objective standard less subject to manipulation for political or budgetary reasons, and it automatically would align stockpile goals with changes in applicable technology.

The AMC opposes establishment of an economic stockpile, as well as use of the National Defense Stockpile for budgetary purposes.

Commodity Agreements

The prices of commodities, at least in a free market, influence their production, so any discussion of minerals availability must take into account their prices.

For several years, the U.S. Government has been involved in discussions about international commodity agreements and a related United Nations Common Fund to stabilize commodity prices. AMC opposes such agreements and arrangements.

We also oppose expanding the International Monetary Fund's Compensatory Financing Facility, as well as its use to underwrite the uneconomic production of surplus minerals.

Erratic price fluctuations have a disruptive influence on commodity-exporting countries in terms of foreign exchange earnings, raising capital for expansion of production, and maintaining employment, at the same time creating planning difficulties for consumer industries.

Hence, the stabilizing of commodity prices obviously appeals to many, but history shows little evidence that international buffer stock agreements designed to manage inventories actually will stabilize prices. On the contrary, experience indicates that commodity price programs such as the International Tin Agreement are poor vehicles for attaining price stability.

AMC, however, does endorse and encourage the U.S. Government to enter into negotiations as the law permits on a case-by-case basis, with the aim of finding voluntary solutions to problems of imbalance in global mineral supply and demand.

INVESTMENT CLIMATE AND TRADE

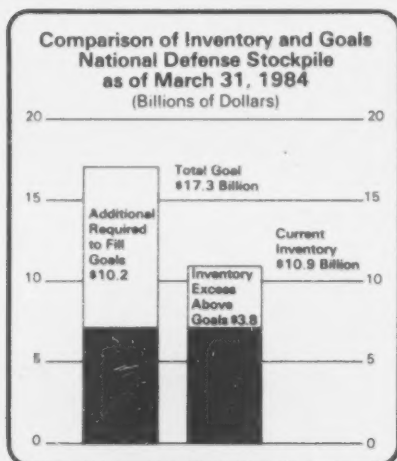
In all aspects of investment and trade, the American Mining Congress supports policies and actions that promote the domestic and foreign commerce of the United States consistent with the maintenance of a viable domestic minerals industry based on private ownership, as set forth in the Mining and Minerals Policy Act of 1970, the National Materials and Minerals Policy, Research and Development Act of 1980 and the National Critical Materials Act of 1984.

To ensure adequate supplies of essential metals and minerals and to eliminate unnecessary dependence on foreign sources, the American Mining Congress strongly urges that U.S. policies not disadvantage domestic mining companies, whether operating here or abroad, and that the United States develop long-term investment and trade policies that comprehensively address U.S. requirements for secure natural resource availability.

Investment Climate

The United States should support domestic industry by promoting an environment of stable economic growth and sound public policy. The mining industry needs a strong, secure economic environment in which to recover from a recession that has been, for this industry, exceptionally long and severe. For many mining companies, indebtedness, already swollen by large expenditures for environmental compliance, has reached levels that approach the limits of borrowing, and a period of stable economic growth is required urgently to rebuild the industry's financial strength. The American Mining Congress urges the Administration and the Congress to:

- Pursue prudent monetary and fiscal policies, including immediate and effective steps to reduce greatly the federal deficits, to prevent the reemergence of inflationary pressures and to eliminate excessively high interest rates and thereby sustain the current economic recovery.
- Adopt tax policies that will encourage capital formation and investment.



Source: FEMA Stockpile Report to the Congress, 1984

- Recognize the importance of encouraging investment in basic industry and the impact that government policies in many areas—environmental, public lands, energy, among others—can have on the ability of the mining industry to generate and compete for investment capital.

The international investment climate is also of high importance to the domestic mining industry. International trade and investment can have a very significant effect on domestic industries, and we urge that international trade considerations be brought more effectively into the central policy-making processes of Congress and the Executive Branch.

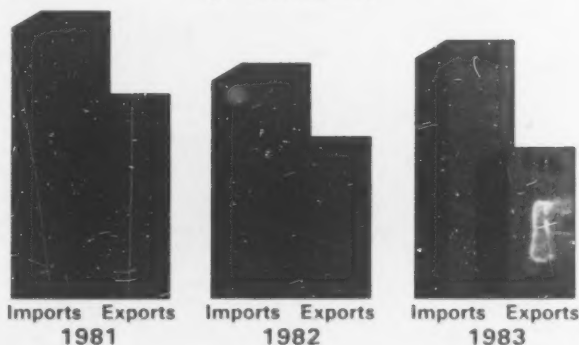
International Trade and Investment

The American Mining Congress supports an open and fair international trading system in which both the United States and its trading partners abide by firm and mutual commitments to play by the rules. Observance of the internationally agreed upon rules of trade discipline of the General Agreement on Tariffs and Trade are essential to this objective. However, the American Mining Congress recognizes that there exist today many limitations to these principles and commitments, and that some existing international trading rules need revision.



George Munroe of Phelps Dodge presents the international trade policy statement.

U.S. NONFUEL MINERAL TRADE DEFICIT (\$ Billions)



Source: U.S. Bureau of Mines

Despite recognition of such limitations, the American Mining Congress continues to believe that U.S. national interest, and the interests of the mining industry, will be best served by adherence to the principles of an open international economy: free access to world markets and world resources; competitive and nondiscriminatory international trade and investment and project financing; and the preservation and strengthening of private enterprise operating in free international markets.

Nevertheless, we urge that the Administration broaden its discussions with our major trading partners and seek new ways to deal with the difficult and intractable problems now affecting major sectors of world trade, such as steel and copper, similar to the actions the President suggested in his recent steel decision.

We support the President's International Investment Policy statement of September 9, 1983, which states that a fundamental premise of U.S. policy is that international investment flows responding to private market forces will lead to more efficient international production and that they constitute "a vital and necessary ingredient in a stable, growing world economy."

But it must be recognized that certain governmental policies—those of the United States and of foreign nations as well—can and do have a significant adverse impact on international trade and investment and the domestic companies affected by such trade and investment.

The American Mining Congress urges the U.S. Government, when responding to unfair international trade practices, to apply existing trade remedies promptly and more consistently and completely and to consider as subsidies the many indirect forms of support that so often accompany state trading in its various modern manifestations.

R.J. Gary, left, of Texas Utilities Generating, and Pierre Goussard of Amas are members of the Resolutions Committee.



The American Mining Congress endorses the 1984 London Economic Summit's call for new international economic discussions under the auspices of the General Agreement on Tariffs and Trade to improve the functioning of the multilateral trading system, to reinvigorate the rules and disciplines governing international trade and to deal with pressing world trade problems not yet subject to GATT rules. Such GATT discussions also would provide an opportunity to update the original GATT rules for "State Trading," which established the principle that state trading should be conducted in a manner consistent with the GATT rules for private trading and that state trading enterprises are to make their import purchases and export sales solely in accordance with commercial consideration and customary business practice.

To the extent that such remedies do not exist, are not applied or are not effective, AMC believes it is important that the federal government take action to minimize the adverse and often unfair impact these U.S. and foreign governmental policies have on domestic industry. Some of these effects are addressed in the remainder of this statement.

Overvalued Dollar

The U.S. trade balance has been impacted severely and adversely by the international and domestic effects of an overly strong dollar. Imports have a significant competitive edge because most foreign currencies have depreciated sharply against the dollar since 1980. The result has been massive U.S. trade deficits—the record deficit of \$69.4 billion in 1983 was surpassed in the first seven months of 1984, and the total 1984 deficit is projected by the U.S. Trade Representative to be \$126.5 billion.

The U.S. mining and mining equipment industries have absorbed a heavy share of the burden of the strong dollar because their products must compete on the basis of price with foreign competition whose costs are incurred largely in currencies that have depreciated against the dollar. Despite these industries' successful efforts to reduce costs through greater efficiency and increased productivity, their exports of minerals and of mining equipment are curtailed by foreign purchasers' resistance to higher effective prices, and imports of foreign goods increasingly displace U.S. production in domestic markets.

The trade distortions caused by the strong dollar are not addressed effectively by the usual kinds of legal protection contained in most U.S. trade legislation. Nevertheless, the American Mining Congress supports the continuing effort to simplify, clarify and improve the policies and administration of U.S. trade statutes.

The American Mining Congress urges that international consultation and surveillance in the appropriate trade and monetary institutions be pursued, strengthened and expedited so that exchange rates are not used or manipulated to gain unfair competitive advantage in international trade. AMC supports increased coordina-



Richard del. Osborne (left) and Ralph L. Hennebach, both of Asarco, discuss the policy statements.

tion of monetary and trade policy to deal with the complex problems of the world economy.

State-Owned or -Controlled Producers

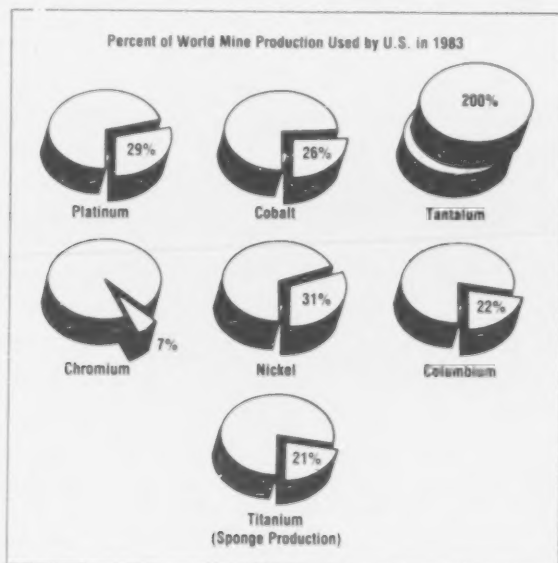
The U.S. mining industry has been hurt severely in recent years by the increasing activities of nationalized, state-owned, -controlled or -subsidized mining and mineral producing and processing industries in certain developing countries, as well as in some industrialized nations, which have disrupted the normal, market-oriented production and sale of minerals. Production of minerals for world markets based on decisions by governments politically motivated to preserve jobs or

generate foreign exchange means that mineral production continues to be maximized during periods of world oversupply, regardless of the cost-competitive position of individual operations. This has had a very depressing effect on the world prices of minerals in the recent recession and to date causing losses or inadequate returns to all producers, including those that are state-owned.

Privately owned mines, such as those in the United States, being subject to the disciplines of the balance sheet, are often forced to close down during periods of world oversupply, whereas the losses of state-controlled producers are met by national treasuries, supported by the International Monetary Fund. The IMF in turn relies in significant degree on funds advanced—for all practical purposes on a permanent basis—by the United States. State-controlled mines seldom adjust their rates of production to reflect prevailing demand.

Banks and Other Lending Agencies

These problems have been created in part by the operating principles, policies and practices of the multinational development banks, chiefly the World Bank, and have been compounded, as noted above, by the IMF. Private commercial banks in this country and abroad also have contributed to these problems by lending (like the development banks) to developing countries to expand their mineral capacity in the face of likely oversupply. These practices have left such countries with



Source: U.S. Bureau of Mines

tries with large debts, but often inadequate means of servicing those debts, and have helped create the serious developing country debt problem.

The 1983 legislation (Public Law 98-181, especially Titles VII and X), authorizing an increased quota for the IMF, made considerable progress in enacting into law many of the recommendations of last year's American Mining Congress Policy Declaration dealing with positions the U.S. Government should take with the multinational development banks and the IMF. The American Mining Congress will continue to monitor closely the effectiveness of this legislation.



Harry Conger of Homestake follows discussion.

The American Mining Congress holds that:

- Multilateral lending institutions' loans to mining projects should be commercially viable and at market interest rates.

- IMF programs to ease a country's debt difficulties should seek to limit their adverse effect on world commodity markets.

- Agencies of the U.S. Government and private commercial banks in this country should not lend to foreign borrowers on terms that are more favorable than those available to domestic mineral firms with similar standing.

We support the competitive lending activities of the Export Import Bank in facilitating United States mining equipment sales or private mining ventures abroad, except where such financing would have significant adverse effect on the domestic mineral industry.

UNDERSEA MINERAL RESOURCES

The oceans contain large deposits of untapped and, to a large degree, unknown resources. Some of the known resources contain minerals—manganese and cobalt, among others—that are of strategic and critical importance to the economy and security of the United States and to other nations as well. The wise development of these resources requires the establishment of a stable and realistic regime under which investors with the necessary capital and skill can exercise their historic right of freedom of the high seas and pursue deep seabed resources in a secure, reasonable and nondiscriminatory manner.

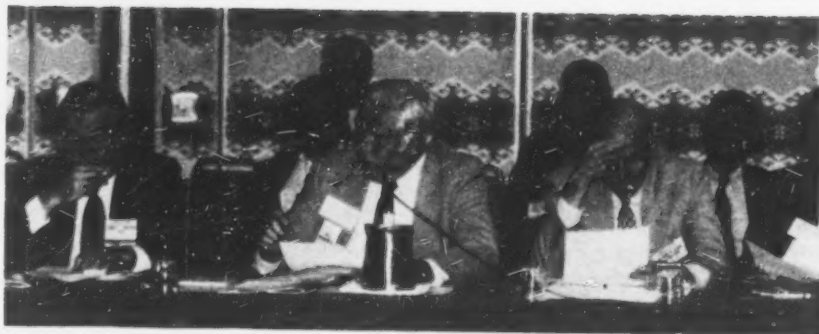
The proposed Law of the Sea Treaty (LOST) provides none of these conditions. In accordance with the President's declaration that its provisions were fundamentally unacceptable with respect to deep seabed mining, the United States properly voted against LOST. The American Mining Congress supports the government in that action.

In 1983 the President proclaimed an Exclusive Economic Zone in which the United States will exercise sovereign rights over resource, economic and environmental matters within 200 nautical miles of its coast. He announced that the United States will continue to work with other countries to develop a regime for mining deep seabed minerals beyond national jurisdiction as a lawful exercise of the freedom of the high seas open to all nations. The American Mining Congress supports the President in that decision and encourages implementing legislation.

AMC welcomes the "Agreement Concerning Interim Arrangements Relating to Polymetallic Nodules of the Deep Seabed," signed by the governments of the United States, United Kingdom, Federal Republic of Germany and France in 1982 regarding the resolution of conflicting claims to areas of the ocean floor filed by so-called "Pre-Enactment Explorers." This interim agreement is a proper step toward an effective alternative regime under the terms of the Deep Seabed Hard Mineral Resources Act of 1980 (P.L. 96-283), and was a significant factor in promoting the resolutions of overlap conflicts among ocean mining applicants in such countries, a private settlement of such conflicts being reflected in an arbitral award enrolled in Paris on 15 June 1984.

The essential element of a stable legal political environment that would permit development of deep seabed mineral resources under appropriate economic conditions, continues to be agreement on appropriate legal arrangements among like minded nations to observe similar rules and regulations and mutually respect exclusivity granted by participants. Thus, the recognition by nations having the necessary capabilities to achieve commercial exploitation of a right to explore and commercially mine the deep seabed is an important step in providing such an environment. Recognition by a larger group of nations would enhance the security of such rights.

In the absence of an acceptable Law of the Sea Treaty,



From left, Robert Cerughini of Keanecon, Thomas Barrow of Solbio, and Raymond Ingram of Exxon Minerals examine the resolutions.

a satisfactory private-enterprise investment climate, beyond the Exclusive Economic Zone, in which industry can obtain the significant financing required for the enormous undertaking of mining the deep seabed, can be created by the establishment of a sufficiently broad network of reciprocal rules and regulations among interested nations and their commitment to support and protect their licensed deep seabed miners, lawfully exercising a freedom of the high seas, from diplomatic, legal and other challenges that already have been threatened on behalf of the International Seabed Authority and its supporters. The basis for such a network exists in part in our Deep Seabed Hard Mineral Resources Act and the legislation in place in the U.K., France, Japan and West Germany and the "Provisional Understanding Regarding Deep Seabed Matters" recently signed among the U.S., U.K., France, West Germany, Italy, Belgium, Holland and Japan.

The AMC applauds the government for signing the agreement and urges it to hold such understanding open for signature by additional countries.

The AMC notes that the Preparatory Commission of LOST has met in several inconclusive sessions to consider the early establishment of LOST institutions and certain rules and regulations regarding deep seabed mining. The AMC urges the government to maintain its absence from these proceedings. AMC also urges the government to ensure that funds furnished by the U.S. to the United Nations, academia, or other organizations are not used for purposes of supporting the operations of the Preparatory Commission, the International Seabed Authority and Tribunal, or the so-called "Enterprise," operating on its own behalf or as a joint venture or other efforts designed to bring LOST into force and effect. Additionally, the U.S. Government should assure itself that potential subsidized marketed products of the Enterprise are subjected to any and all economic legislation dealing with imports, and that the International Seabed Authority, its organs and the Enterprise are granted no privileges, including tax and diplomatic immunity and most favored nation status, in the United States.



AVAILABILITY OF LANDS

PUBLIC LANDS

The national security and general welfare of the United States depend on an adequate mineral supply at reasonable costs. This supply can be assured best by private-sector exploration for and production of minerals from the public lands guided by policies that recognize:

- While exploration requires access to but minimum impact upon large areas, the discovery and development of a mine occupies a small area, providing a large resource output for the land area used.
- Mineral development can be undertaken only where minerals occur.
- Improved technology and economics may justify exploration in previously explored areas and the development of previously uneconomic deposits.
- Security of title under the general mining laws and adequate tenure under the Mineral Leasing Acts are necessary to justify the large capital investment needed for mineral development.

Social and environmental legislation and regulations, without benefit of adequate natural resource and economic data, have complicated, restricted and, in many cases, denied mineral exploration and development on public lands.

The American Mining Congress supports the revision of regulations to facilitate access and mineral development on public lands, review of all existing mineral withdrawals, revocation of those withdrawals that are unnecessary and limitation of additional withdrawals.

General Mining Laws

AMC supports retention of the general mining laws and opposes suggestions to place locatable minerals under a leasing system. A leasing system would discourage and reduce mineral exploration and development and would preclude individuals and small firms from these activities.

Experience under the Mineral Leasing Acts, with their attendant rulemakings, environmental clearances and exposure to delaying litigation, has shown clearly that the extension of such a system could close public lands to hard mineral exploration for decades—a hiatus that the nation can ill afford.

The Federal Land Policy and Management Act of 1976 includes provisions requiring recordation of unpatented mining claims, and for clearing stale claims from public lands. The language of the Act is straightforward; the intent of Congress is clear. However, unnecessarily aggressive administrative actions and interpretations have resulted in extensive litigation by mining claimants, and the constitutionality of the stale claims provision is now being challenged in the Supreme Court of the



David DeLoach of Amex reads the public lands resolution.

United States.

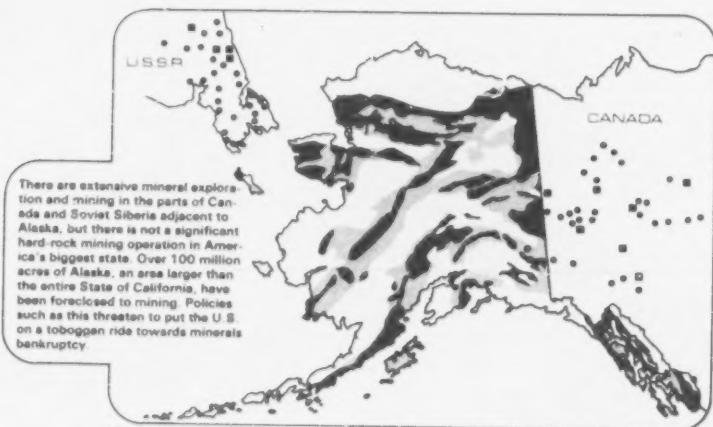
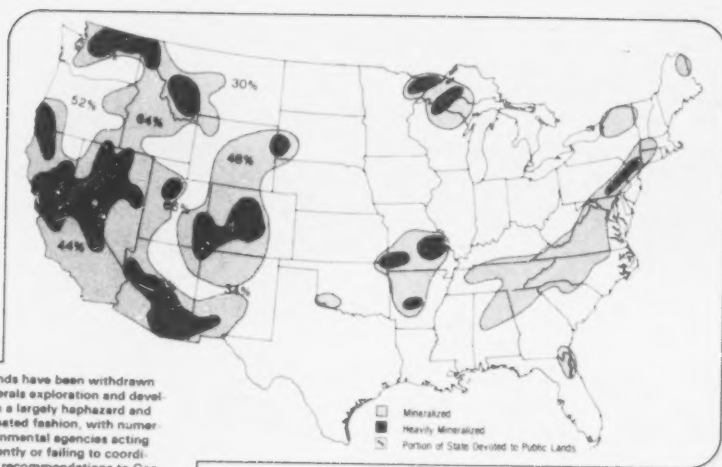
AMC supports the concept of recordation and stale claim termination, and urges the agencies to take such action as is necessary to provide for clearing of stale claims in a fair, consistent, certain manner while providing sufficient flexibility to avoid harsh and unfair impacts.

Multiple-Use Land Management and Land Withdrawals

AMC endorses the principle of multiple-use management of public lands. Areas should not be closed to mineral exploration or mining in the absence of a rational and objective determination that other national interests override the need for the minerals that may be supplied from those areas.

Public land management regulations designed to carry out single special purposes have multiplied and exceeded the intent and authority of the statutes under which they were promulgated. The cumulative result has been a serious curtailment of and a lengthened process for mineral exploration and development activities upon public lands. AMC urges that changes be made in these regulations to simplify the process for entry upon and development of minerals on public lands.

The exact acreage of federal lands withdrawn is not known, but much with the best potential for mineral



Source: U.S. Bureau of Mines

- Highly Favorable for Metallic and Related Nonmetallic Deposits
- ▨ Favorable for Metallic and Related Nonmetallic Deposits
- Active Hardrock Mines
- Major Hardrock Exploration Development Programs
- Continuing Exploration Programs

discovery is off limits. We estimate that two-thirds of all public lands are closed entirely or partially, and the acreage closed is increasing each year. AMC supports a review of existing withdrawals to pinpoint their location and acreage. AMC urges the Department of the Interior to revoke those withdrawals that are unnecessary and to limit additional withdrawals to only that acreage that is essential to carry out the purpose of the withdrawal.

Wilderness Areas

In recognition of the continuing mineral demand and constant change in mining and exploration technology, Congress should amend the Wilderness Act to eliminate prohibitions on exploration and excessive restrictions on mining in wilderness areas. It should not legislate buffer zones for wilderness. Provision should be made for periodic review of existing wilderness. Efforts should be made to modify wilderness boundaries to exclude highly mineralized zones.

BLM Wilderness Program—Lands under the jurisdiction of the Bureau of Land Management are being studied to determine their suitability for wilderness designation. The Department of the Interior has ruled that, during the study, nonimpairment restrictions will be placed on mineral activities in these wilderness study areas. The administrative interpretations and policies imposing these restrictions are contrary to law. The Department of the Interior should correct those interpretations and policies to conform to the intent of the Federal Land Policy and Management Act and the Alaska National Interest Lands Conservation Act. This would allow us to proceed under rules and regulations of the general mining laws. These lands then would be opened to mineral exploration, appropriation and development. Effective, specific provisions for "release" of BLM wilderness study areas need to be legislated.

U.S. Forest Service Roadless Areas—With respect to lands reviewed for wilderness suitability by the Forest Service in its Second Roadless Area Review and Evaluation (RARE II):

- 1) The President should reconsider the excessive acreages recommended for wilderness.
- 2) Forest Service lands recommended for further wilderness study or recommended wilderness, but not yet included in the Wilderness System, should remain open and be managed to allow mining pursuant to existing law.
- 3) Forest Service lands recommended for multiple-use management should be so managed without further delay.
- 4) Congress should find the RARE II environmental impact statement to be legally sufficient.

Coal Leasing

Development of federally owned coal is essential in supplying the nation's energy needs and alleviating its adverse balance of payments in international trade.

AMC believes that Congress should move expeditiously to enact legislation to correct unrealistic produc-

tion obligations and other impediments to reasonable coal development embodied in the Federal Coal Leasing Amendments Act (FCLAA) of 1976.

Most urgently required is repeal of the provision in Section 3 of the FCLAA that bars the Secretary of the Interior from issuing leases to an entity that holds and has held a federal coal lease for 10 years without producing coal in commercial quantities.

Following the passage of FCLAA, implementation of the Federal Coal Management Program by the Bureau of Land Management also caused AMC concern regarding the adequacy and timeliness of future coal leasing. Revision of the program by the Secretary of the Interior in 1982 to eliminate "excessive, burdensome, or counter-productive" regulations was a needed first step in encouraging the development of federal coal. Current efforts by the Department of the Interior to revise the program further should be governed by the fact that additional encouragement of federal coal development is needed.

Administration of the Federal Coal Management Program must permit sufficient reserves to be available for development to meet the requirements of coal consumers as their demands expand. This should be accomplished by leasing sufficient federal coal under flexible terms for development, thereby permitting normal supply-demand forces to establish a market price.

In this respect, AMC supports the findings and recommendations of the Linowes Commission on Fair Market Value Policy for Federal Coal Leasing to the extent they conclude that the government (1) should not use its unique ownership position in western coal to raise the price above the competitive market level, (2) should ensure ample diversity in quantity and quality of federal coal offered for lease, and (3) should ensure predictability and stability in its coal leasing actions.

AMC opposes any moratorium on federal coal leasing as not in the long-term, best interest of the United States. AMC also opposes any effort to impose unrealistic production requirements on federal leases.

The Federal Coal Management Program places great importance on land use planning and environmental protection. Such land use as occurs on federal coal leases is temporary in nature, and proper reclamation required by other statutes provides protection from permanent adverse environmental effects. The necessity to restore and maintain the vitality of the national economy, and to make the most efficient use of the nation's rich natural resources, requires that coal production, as a use of the public lands, be given a high priority.

The program and the leasing statutes also fail to take into account that the demand for metallurgical coal (used in blast furnaces) rises and falls in concert with steel production, making diligent production requirements an unreasonable burden when steel production slumps. Thus, AMC supports the exemption of metal-

lurgical coal from inflexible diligent development and continued operation requirements.

Water Rights Determinations

The assertion of federal and Indian reserved water rights, which has generated considerable litigation and uncertainty, poses threats to water rights vested under state law and sanctioned by federal law. Congress should enact comprehensive legislation to (1) reaffirm the dominant state role in water rights administration and adjudication, (2) limit the scope of federal reserved water rights so that impact on exercise of state water rights is minimized, (3) determine federal and Indian reserved water rights upon detailed and timely investigation and analysis of all issues raised by the conflicts, (4) determine when federal and Indian reserved water rights may be established in the future, and (5) investigate the potential for water conservation and development projects that would ameliorate the conflicts between the exercise of federal and Indian reserved water rights and water rights established under state law.

LAND-USE PLANNING

Land-use planning has become a means of restricting rights of mineral discovery, development and ownership. Several environmentally oriented federal statutes have resulted in direct and indirect land-use controls, including the Clean Air Act, Federal Water Pollution Control Act, Federal Land Policy and Management Act, Resource Conservation and Recovery Act, Endangered Species Act, Surface Mining Control and Reclamation Act, Federal Coal Leasing Amendments Act and the Wilderness Act. Land-use decisions made at the federal and state levels to implement these laws too frequently

have resulted in indiscriminate segregation of lands from both public and private use.

AMC urges that all land-use legislation, planning proposals and implementation of existing statutes recognize the unique nature of mineral occurrences. Minerals can be mined only where they are found. Environmentally sound operations are mandated by law.

AMC urges government at all levels to:

- 1) Implement land-use planning in a manner consistent with the policy expressed in the Mining and Minerals Policy Act of 1970 and National Materials and Minerals Policy, Research, and Development Act of 1980.
- 2) Manage the lands in accordance with multiple-use principles.
- 3) Recognize that mining is among the highest and best uses of the land.
- 4) Establish a "zero-based" land-use planning system so that withdrawals can be reviewed and justified during each planning cycle.

INDIAN LANDS

AMC supports the development of rules that give Indian mineral owners greater responsibility and more flexibility to negotiate mineral agreements. However, current proposed regulations by the Bureau of Indian Affairs are not in the best interests of the Indian mineral owner or the minerals industry. The July 1983 proposals ill advisedly set forth criteria for determining when mineral agreements are in the best interest of Indian mineral owners and are deficient with respect to unitization for minerals, allowing preference right leases, and deflating production in paying quantities. These are among the items that defeat the objectives of existing laws governing mineral development of Indian lands.



From left, Robert McInnes of Pickands Mather, John Farley of Jones & Laughlin Steel, and Kenneth Barry of Amoco Minerals examine the public lands policy statement.

ENERGY



Frank McPherson of Kerr-McGee was chairman of the Resolutions Subcommittee on Energy.

ENERGY SECURITY

The American Mining Congress endorses an energy program that will lead to greater national energy security, albeit recognizing that energy development is a global concern. The present excess foreign oil production capacity should not be allowed to slow the exploration for and development of domestic supplies of conventional energy and development of alternative fuels. Development of domestic energy sources should have high priority in the national policy, consonant with market-determined price, and cost-efficient regulations designed to protect the environment and the health and safety of all our citizens.

AMC supports the concept of tax policies designed to encourage the exploration for and the development of domestic energy supplies. Discriminatory tax policies aimed at a specific segment of the energy industry will undermine the achievement of these goals and should be avoided. AMC believes that domestic energy production, including alternative fuels, and conservation of energy, will be enhanced by the following:

Socioeconomic Impact

- Cooperative efforts among the public, government entities and private sector energy companies in dealing with socioeconomic impacts of energy-related projects.

Regulated utilities should not be used as political instruments, and regulators should ensure that the

actual cost of providing the service is the primary factor in establishing rates.

Oil and Gas

- Establishment of reasonable and predictable access provisions to encourage exploration for and development of oil and gas resources on state and federally controlled lands, both onshore and offshore.
- Accelerated repeal of federal regulation of natural gas and total decontrol of prices, without contract abrogation.
- Enactment of mandatory contract carriage of natural gas to the extent of available pipeline capacity, enhancing a competitive market for natural gas.
- Establishment of a streamlined permitting process for major projects.
- Increased strategic storage and pragmatic utilization programs to protect the nation in the event of oil import interruptions.

Coal

- Modified environmental statutes and regulations so as not to discriminate against the use of coal as a domestic and international energy source.
- Substitution, where appropriate, of performance standards for specific engineering and control regulations to achieve environmental goals and increase productivity.
- Continued coal leasing on federal lands.
- Development and modernization of all modes of transportation, including coal slurry pipelines and port facilities, to support the efficient and economic movement of coal to domestic and foreign consumers.
- Balancing costs and benefits, based on the best available scientific evidence, when establishing emission standards.

Nuclear

- Positive governmental policies for the domestic development of nuclear energy, recognizing its necessity and benefits, and governmental support for a viable domestic uranium production industry.
- Revision of the government's enrichment policy to assure that the nation is competitive with foreign sources.
- Consideration of alternative means for financing, constructing and operating nuclear reactors to encourage public confidence in this energy source and its economics.
- Congressional action to reduce delays and streamline siting and licensing procedures.
- Balancing costs and benefits, based on the best



Wayne Ewing, Peabody Coal, submits the policy statement on coal surface mining.

available scientific evidence, when establishing standards and regulations for controlling mill tailings and radionuclide emissions.

- Use of independent scientific organizations to assist agencies in developing regulatory controls based on sound scientific data.
- Informational programs for students, legislators, the media and the public with respect to the desirability and safety of nuclear power.

Synthetic Fuels

- Continuation of federal support of research and development efforts on synthetic fuel options.

COAL SURFACE MINING

The American Mining Congress supports efforts by the Department of the Interior to implement the Surface Mining Control and Reclamation Act of 1977, which was intended to "strike a balance between protection of the environment and agricultural productivity and the nation's need for coal as an essential source of energy."

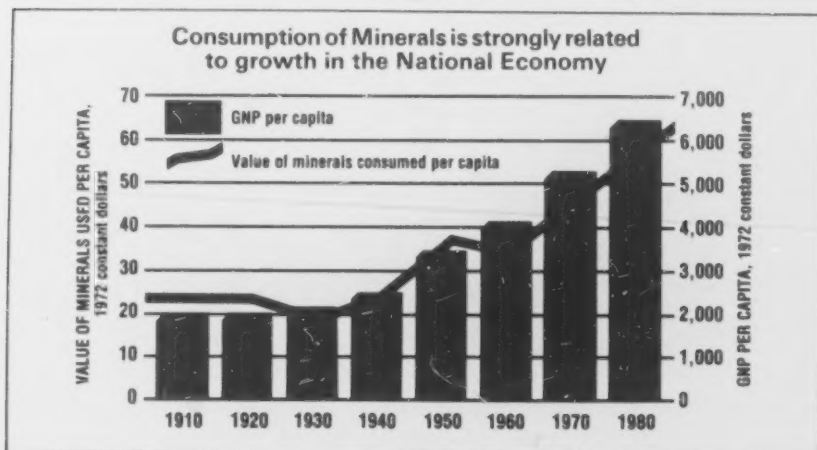
We believe that good stewardship of the land includes restoring it after it has been surface mined for coal to a condition suitable for further beneficial use.

AMC has cooperated actively with the Interior Department in its program of eliminating unnecessary, burdensome, and counter-productive regulations, and we will continue to offer constructive participation.

Many of the revised regulations are now the subject of litigation, with challenges having been filed by both industry and environmental organizations. We hope these legal actions will serve to clarify and resolve the issues of statutory authority raised during the rulemaking process.

With primary regulatory authority over surface mining now residing with the states, we urge the Interior Department to exercise its oversight function in a judicious and responsible manner. It is essential that the Department assure that the states are complying with the provisions of the Act, while preserving their statutorily guaranteed autonomy in implementing their programs.

We urge the states to refrain from implementing unreasonable or restrictive regulations that could jeopardize coal production and to eliminate such regulations where they now exist. This will allow them to take full advantage of the flexibility granted them to develop programs that meet local conditions.



Source: Bureau of Mines, *The Domestic Supply of Critical Materials*, 1988.

American Mining Congress Journal

ENVIRONMENTAL QUALITY

National policies on the environment should recognize that attainment of national goals requires a vigorous and economically sound domestic minerals industry. The mining industry is committed to protecting public health and supports environmental policies that will reach that goal effectively.

1) Clean air statutes and rules should emphasize the attainment and maintenance of scientifically valid ambient air quality standards designed to protect public health. Several existing and proposed standards are not based on sound scientific data and should be revised. As a specific example, standards for particulate matter should be revised to exclude fugitive dust emissions from mining due to their proven lack of significant health and welfare impacts. The Clean Air Act should be amended to provide relief to existing nonferrous smelters that otherwise may be required soon to commit to installation of unnecessary, costly emission control technology. Aesthetic concepts, such as prevention of significant deterioration and protection of visibility, should be examined critically, weighing any tangible benefits against the restrictions placed on natural resources development.

2) Proposed legislative initiatives aimed at controlling acid deposition are premature. It is wholly uncertain

whether costly reductions in sulfur dioxide and nitrous oxides will achieve commensurate reductions in acid deposition or adverse impacts in sensitive receptor areas. At present no public health threat is known to exist. The causes of forest decline in limited geographical areas are unknown and do not represent a crisis. Undesirable acidification of lakes may be controlled adequately at significantly more modest cost. New hypotheses are being proposed and tested under the research program implemented under the Acid Precipitation Act of 1980. Data from this program have revealed that some earlier theories about acid deposition may have been oversimplified, unrealistic or incorrect. Congress should accelerate the research program in the areas where the greatest uncertainty exists. In the interim, appropriate action should be taken to mitigate any identifiable harmful effects of acid deposition. Federal grants should be made available to the states for developing and implementing innovative on-site mitigation techniques as well as proven mitigation measures.

3) Clean water statutes and rules should be designed to achieve water quality that allows beneficial use of the receiving water while at the same time safeguarding important aquatic life. It should be a national goal to eliminate the discharge of pollutants in harmful quantities to achieve such water quality within a time frame set by economic and technical feasibility. States should be encouraged to adopt water-quality use designations and criteria keyed to site specific characteristics of individual water bodies. The Clean Water Act also should be modified to lengthen the term of permits, extend the deadlines for compliance with technology-based standards, simplify the "dredge and fill" permit program and apply it only to those wetlands truly in need of protection, exempt structures and conveyances that divert storm water runoff from the definition of "point source," exempt new source discharges from the requirements of the National Environmental Policy Act, and ensure that water quality-based standards are applied to discharges to ephemeral or intermittent streams only on a case-by-case basis when there is significant environmental benefit from such action.

4) Waste material resulting from the extraction, beneficiation and processing of ores and minerals should not be designated as "hazardous" merely on the basis that such material contains small amounts of natural elements that in some specific form or quantity may be deemed hazardous to life forms. It should be recognized that conventional mineral waste disposal sites do not fit any of the current regulatory classifications. Site-specific physical conditions and mineral-specific waste analyses should be considered when establishing regulatory pro-

Edward Bingham of Amas Environmental Services presents the proposals on environmental quality.





From left, Walter Oosterman of Kaiser Cement and Wayne Burt of Newmont, follow the discussion on the environment.



Charles Barber of Anasco Inc.

grams for mineral waste disposal.

5) While AMC agrees with the need for a fund to finance necessary cleanup of hazardous chemical waste dumps, proposals to expand the tax base to include metals at increased fees are without environmental merit. EPA leadership has expressed concern over the agency's ability to manage properly sudden, huge increases in the amount of money available for Superfund purposes. Any increases in the level of funding should be incremental, consistent with estimates of the short-term cleanup needs and with the government's ability to maintain a reasonable balance between funds collected and those spent. When reauthorized, Superfund should not include provisions for a federal cause of action as a legal remedy for alleged harm or damages, and should not include taxes on waste products that would apply fees inappropriately to high-volume, low-toxicity mining and mineral processing wastes.

6) Groundwater is a valuable resource that traditionally and appropriately has been managed and protected by the states. The federal government has sufficient authority under existing environmental statutes to protect groundwater in the event such action may be needed to protect human health. No new federal legisla-

tion is needed to protect groundwater quality. The federal role in this area should be limited to enforcing existing statutes and providing technical and financial assistance to the states, with the U.S. Geological Survey providing the base of expertise.

7) The process for obtaining permits for new projects or modifications of existing facilities should be streamlined.

8) Regulatory actions must reflect a realistic balancing of costs and benefits. Agencies must use established scientific procedures, including assessment of risks and recognition of the limitations of analytical tools such as theoretical models, to ensure the objectivity and validity of standards. No regulatory actions should be taken unless they are based on sound scientific data that have been subjected to peer review within the scientific community.

9) Statutes and rules for protecting specific elements of the environment should be neither designed nor used for land-use planning, which is a local prerogative and a process in which the physical environment is one of the many issues considered in planning for the welfare of the community at large.



Earl Huntington and Gino Ghisli, both of Tennacell Inc.



Listening to the debate on environmental resolutions are, from left, Ralph Cox, Atlantic Richfield, and Bernard Roy, Amstar.

SAFETY AND HEALTH

MINE SAFETY AND HEALTH

The mining industry continuously seeks to promote and provide a safe and healthful working environment for its employees, whose well-being is of paramount concern.

Achieving this goal requires cooperative safety and health programs to detect, evaluate and eliminate the causes of illness and injury. The American Mining Congress will cooperate with government to:

- Research and identify potential causes of injuries and illnesses.
- Develop, promote and present safety and health training programs.
- Encourage use of mining techniques, machinery, equipment and monitoring methods that provide better control and reduce safety and health hazards in mines.
- Promulgate, revise or revoke standards and product approval requirements, so that the regulatory regime better reflects differences in mining methods, conditions, and processing operations; offers flexibility in reducing documented safety and health risks; does not hinder introduction of new technology; and incorporates clear and concise performance requirements.
- Eliminate duplicative efforts, increase efficiency of governmental agencies and avoid their further unnecessary intervention.
- Develop efficient and fair procedures for resolving disputes.



Robert Knapch of Asarco, chairman of the National Mine Safety Committee, promotes the plank on mine safety and health.

Within the industry, AMC will continue to cooperate with employees for attainment of these objectives and to encourage individual responsibility, habits and attitudes necessary to reduce injuries and illnesses.

AMC supports prompt regulatory and legislative reform to reduce unwarranted burdens on industry while improving safety and health by modernizing outdated legislation and regulations. AMC encourages government to focus its finite resources on true problem areas. In this manner, counterproductive interference with successful industry programs will be avoided, and the benefits of governmental efforts will be maximized.

AMC pledges its continued cooperation in achieving the common goal of all parties involved in safety and health: the protection of the workforce.

INDUSTRIAL RELATIONS

The national interest requires that management, labor and government so conduct their relations with one another as to improve productivity, minimize disputes, eliminate wasteful inflationary practices and enhance the capacity of American business to compete successfully in the world marketplace.

In meeting these requirements, management and labor should recognize that both are employees working for shareholders, though they perform different functions within the private enterprise system. In discharging their separate but interdependent responsibilities, they should respect each other's rights and be mindful of the public interest. Government should discharge its appropriate function in the labor-management field in a consistent, restrained and impartial manner.

The national interest requires that in the enactment and administration of labor-management relations laws, the following precepts be adhered to:

- 1) Free and informed choice should be assured in employee decisions on whether or not to be represented by a union, with that choice protected by secret ballot, and no person's job should be dependent upon membership or nonmembership in or payment or nonpayment of fees or dues to a union.
- 2) All levels of government—federal, state and local—should assert and enforce the tenet of fundamental public policy that government employees have no right to strike, because with their employment they voluntarily assumed special obligations to the public. All levels of government should avoid granting wages or benefits to public employees that lead to accelerated inflation.
- 3) National emergency dispute provisions of existing law should be followed; government should not assume authority to impose terms for settling private-sector disputes.



John Johnson of Newmont delivers the industrial relations statement.

4) Public funds should not be used to support strikes, directly or indirectly.

5) Congress should accord priority to redressing the anti-employer bias present in many laws and regulations, and in the administration thereof, involving the labor-management relationship, including the National Labor Relations Act, occupational safety and health laws and regulations, mine safety and health laws and regulations, and nondiscrimination laws and regulations.

6) There should be no impairment of management's authority to decide whether or not plants and facilities should be closed or relocated or whether the work force at any plant or facility should be reduced, transferred or terminated. In exercising such authority, management should be sensitive to the needs of its employees and of the community involved.

Both labor and management, and the public as well, are served poorly by unwise or unbalanced laws and regulations, by poor administration of any law, or by bias in any government policy.

In addition to a concern about laws and regulations, management and labor share other important interests and objectives. These include:

1) An economy that is sufficiently strong to provide stable and rewarding employment both for current members of the labor force and for future entrants.

2) A fair level of compensation.

3) A reasonable return to shareholders.

4) Earnings sufficient to permit the reinvestment required by an expanding economy and to maintain the worldwide competitiveness of the U.S. mining industry.

5) Promotion of safe and healthful work practices and conditions.

6) Quality products that can meet domestic and foreign competition successfully.

Accordingly, we urge upon management and labor a vigorous enlightened, coordinated and joint effort to meet these objectives and, in so doing, to reduce unneeded and inflationary product costs by improving productivity and curbing or eliminating restrictive work rules and other counterproductive practices. All government policies should encourage such efforts by management and labor.

PRODUCT LIABILITY

Product liability claims alleging work-related injury and disease continue to be a significant problem for equipment manufacturers and others in the mining industry.

The American Mining Congress and other industry groups have attempted to find appropriate ways for product manufacturers and suppliers, as well as product users, to share equitably in the costs of compensating workplace injury and disease claims. These efforts have not succeeded yet.

The increasingly broad application of the tort law doctrine of strict liability to such claims by employees against manufacturers and suppliers of equipment and materials has led frequently to inequitable results.

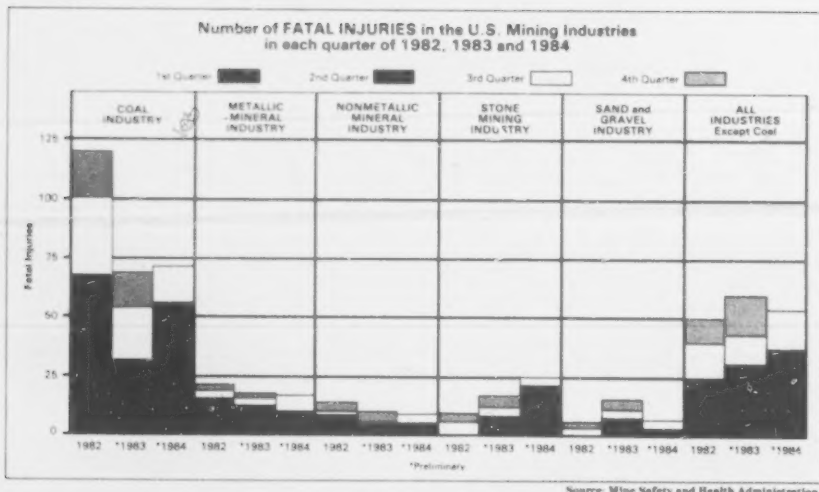
In the context of third-party tort actions, AMC supports reform to:

- Limit strict liability to cases involving defects in construction or breach of express warranty, and apply a negligence standard to cases involving a design defect or failure to warn.

- Require, as part of a case involving the issue of



C.A. "Tink" Campbell, Goodman Equipment, is the chairman of the Product Liability Committee.



causation, the claimant to establish the identity of the manufacturer of the product that is alleged to have caused harm.

- Render it a complete defense if, at the time of original manufacture or production, a unit of equipment or other product was in compliance with state-of-the-art standards for design, manufacture or labeling (including warnings).
- Provide a complete defense for the manufacturer if the product was modified or altered after it left his control, if such modification or alteration was not made pursuant to the manufacturer's direction and had a causal relationship to the injury.
- Construe broadly product misuse and thereby provide a defense ensuring that the manufacturer not be required to assume the burden of another's fault.
- Preclude admission in any product liability action of evidence of subsequent improvements in the safety of a product made by the manufacturer or producer, or advances in the state of the art.
- Limit punitive damages, if permitted at all, to the most flagrant cases where there is clear and convincing proof of a knowing disregard of health and safety standards. Damages for pain and suffering should bear a reasonable relationship to proved economic loss and be disposed of in an appropriate manner.
- Permit admission of evidence of a claimant's carelessness or the carelessness of his or her employer or fellow employees.
- Establish a statute of repose, running from the moment the manufacturer or producer sold or relin-

quished possession and control of the finished product.

- Establish a statute of limitation, running from the moment a claimant discovers or, in the exercise of reasonable prudence, should have discovered the harm and its cause.
- Provide for suitable limitations and restrictions on contingency legal fees in product liability cases.

In pursuit of these reforms, AMC has endorsed uniform federal tort law proposals, such as those provided in S. 44 and H.R. 2729 (98th Congress).

We believe that the search for suitable workplace liability remedies must continue at both state and federal levels, although we are wary of proposals to find product liability answers in federal workers' compensation laws. Federally administered compensation programs to date have proved to be far more costly than anticipated, and their administration has encouraged abuses.

Many states are reviewing their workers' compensation laws to revise benefit levels, adjust coverage or eliminate areas of abuse. Such reviews present an opportunity to reestablish workers' compensation as the primary or sole remedy for work-related injury and disease claims and to apportion equitably among the parties any increased costs involved.

To assist firms unable to obtain product liability insurance on reasonable terms and insured firms needing to provide against large retained risks, AMC supports legislative proposals to recognize, for tax purposes, reserves set up to provide against potential product liability claims.

TAXATION

Essential to the U.S. mining industry's ability to meet the challenge of supplying the nation's minerals needs is a federal tax system that encourages investment of capital in the high-risk mining industry. This system should embody the fundamental principles of certainty of treatment and recognition of the full, current deductibility of legitimate business expenses.

The American Mining Congress believes that a number of the tax system's elements are of critical importance and must be retained. Among these are the Accelerated Cost Recovery System, the investment tax credit, the deduction for mine exploration and mine development costs, and the percentage depletion allowance.

Any major revision of the tax system, such as adoption of a flat-rate tax, should be made in a manner that preserves these elements, which provide incentive for the mining industry to survive and grow.

AMC further believes that the tax system could be improved significantly by adoption of changes that would:

- Take cognizance of the mining industry's depressed economic state through greater recognition of losses, whether operating or capital, and earned but unused investment tax credits.
- Make the benefits of investment credits and cost recovery allowances earned in the future equally available to taxpayers, even though they suffer depressed or nonexistent profits.
- Recognize the importance to the mining industry of full deductions for cost recovery, mine exploration and development expenses, and percentage depletion by eliminating the cutbacks in these incentives, whether those cutbacks have been made directly or indirectly through the corporate "minimum tax."
- Accord greater recognition to the economic burden of nonproductive pollution prevention and abatement facilities and other government-mandated expenditures.



Dennis Bodell of Miller & Chevalier is AMC Tax Committee chairman.

- Allow U.S. mining companies to compete more effectively abroad by providing that foreign tax credits include (a) carryover periods that are consistent with those now allowed for investment tax credits and operating losses, and (b) domestic loss recapture treatment comparable to that mandated for foreign losses.

Finally, we consider it urgent to address the growing problem of taxes imposed at the state level. These taxes constitute an increasing burden on the mining industry and an impediment to the success of its mission in society.

Two trends are of particular concern and should be reversed: First, the increasing level of nonincome-related taxes on the mining industry, such as severance and property taxes; and second, the tremendous administrative burdens imposed on multistate companies by the efforts of states to raise income taxes through adoption of variances from the federal income tax.



Robert Anderson (left), Hanna Mining, and Samuel Scwell, Cleveland-Cliffs Iron, listen to policy discussions.



Robert Quisenberry (left) of Peabody Holding, and Philip Malenkov of Newmont Mining take part in the deliberations.

REGULATORY REFORM

Excessive and unreasonable government regulations continue to plague the domestic minerals industry. They not only impair its competitive capabilities, but they generate uncertainty about future supplies of raw materials and impel users to rely increasingly on imports. This is most evident in segments of the industry that must compete in the international marketplace, where add-on costs cannot be passed on readily to customers.

Regulatory reform is needed not only to protect society and the environment, but also to preserve industry's ability to operate efficiently and to produce products that are economically competitive. This reform ought to be achieved through cooperative efforts of government and industry.

Reform Guidelines

Wherever possible, regulations and their implementation should reflect a careful balancing of costs and benefits. Marginal benefits at exorbitant costs make little sense, if any, either economically or environmentally.

Ideally, improvements in the regulatory regime would encompass at least the following reforms:

- Streamlining and speeding up permitting and licensing procedures to allow productive enterprises to "get on with the job."
- Eliminating jurisdictional overlaps and conflicting goals among regulatory agencies, so that industry plans are neither squeezed in a vice nor lost in a fog.
- Relying on performance standards instead of design specifications to achieve stipulated goals.
- Basing proposed rules on proven scientific data, derived by means of established scientific procedures, which include recognition of the limitations of analytical tools such as theoretical models.
- Mandating peer review within the scientific community of proposals and their justifications.
- Allowing affected parties to unearth and examine the factual basis for agency actions through, among other things, cross-examination of witnesses and consultants relied upon by the agency.

Status

In the past, regulatory authorities often failed to account properly for costs of compliance, dictated means as well as objectives, and failed to establish priorities for their goals.

Many of these problems were directly attributable to enabling legislation passed by Congress, which aimed at conflicting goals, created jurisdictional overlaps, and

provided only vague guidelines by which regulatory agencies had to proceed.

Still, there has been some progress. The Reagan Administration has engaged in an ambitious program to eradicate unreasonable, duplicative and unnecessary regulations, and a number of them that directly affect the mining industry are under review.

Largely because of Executive Order 12291, administrative agencies have begun to consider more carefully both the costs and benefits of regulations, but much remains to be accomplished.

The American Mining Congress supports the expeditious completion of regulatory reform proceedings now underway and congressional action to institutionalize reform in the future.

We support legislation such as the Regulatory Reform Act (S. 1080), which unanimously passed the Senate in the 97th Congress. Legislation of this type would institute many of the key reforms mentioned earlier. Congress should pass it without delay.

Venue Reform

Also in need of reform are several provisions of the U.S. Code that prescribe venue limitations for lawsuits challenging federal regulations.

These provisions allow petitioners to file their suits only in the U.S. Court of Appeals for the District of Columbia Circuit or the U.S. District Court for the District of Columbia. They should be modified to ensure that agency rules are subject to review in forums consistent with the interests and convenience of the parties in the suit.

Venue reform is also necessary to address instances where suits challenging federal regulations are brought in courts far removed from the areas of the country where the regulatory impact will be felt. The law should allow the transfer of such suits to federal courts located in the areas of impact.

Douglas Bourne, Duval Corp., offers regulatory reform resolutions.



TRANSPORTATION

As a major shipper of bulk commodities to domestic and foreign markets, the mining industry is vitally concerned about all modes of transportation—their development, modernization, efficiency and the costs of using them.

In this regard, the most widespread and serious problem centers on the railroads and the power of the railroads to set certain rates, particularly for coal haulage.

Although railroads were deregulated in 1980, it was recognized that where a railroad held a transportation monopoly, the Interstate Commerce Commission (ICC) could prevent abuses of "market dominance."

It is the position of the American Mining Congress that the ICC has been devoted excessively to improving the financial condition of these railroads, largely disregarding the need to protect their captive shippers against monopoly pricing.

Under a draft ICC policy, market dominant rail carriers could double their rates for coal in five years and triple them in eight years—after inflation!

We support the goals of the legislation that was meant to deregulate and rehabilitate America's rail system in order to meet the needs of interstate commerce and national defense, but that legislation also sought to prevent abuse of captive shippers.

We believe the coal rates permitted under the ICC draft policy are an abuse of monopoly power and a violation of congressional intent.

AMC supports administrative actions, legislative alternatives and possible litigation aimed at reaching the goal of balance in meeting the needs of rail carriers and shippers alike.

We also support private and public actions aimed at increasing competition in the transportation of bulk commodities. Recent examples of competition, including the new Chicago and Northwestern rail line as well as the potential of coal slurry pipelines, have demonstrated positive effects on rail rates. In addition, we support Staggers Act provisions, including section 208 contract authority, that permit coal producers and carriers to aggressively market their products and services.

Of course, rail is not the sole mode of transportation of keen concern to the mining industry. The nation's ports and inland waterways are also essential components of the transportation system.

We believe the federal government has primary responsibility for the maintenance and improvement of waterways facilities and urge that appropriate actions be taken to enhance commerce and increase U.S. export competitiveness. We oppose the concept of cargo preferences.

Finally, AMC supports the present heavy reliance upon competition in the trucking industry, with appropriate regulation and enforcement of adequate safety measures.



COMMUNICATIONS

To promote understanding of the central role of mining in American society, we support a program of broad educational communication with the public. Its aim is to convey the importance of mining and minerals to the economic vitality and national security of the United States and to each of its citizens.

This communications effort also should strive to engender in all segments of the mining industry a pride in its accomplishments and a willingness to speak out on its behalf.

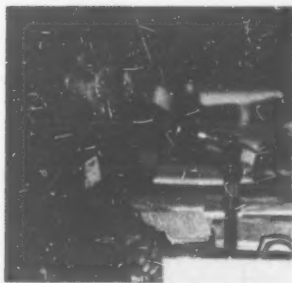
The program can reach a wide and diverse audience by a number of means, including:

- Use of local and national news media.
- Dissemination of printed and audiovisual materials by the American Mining Congress and its member companies.
- Presentations by knowledgeable industry representatives before educational, civic and other groups throughout the nation.
- Development of appropriate educational materials for elementary and secondary school curricula.

The nation would be served well by a better public awareness that modern society depends on the work of the minerals industry, that mining represents only a temporary and safe disturbance of the land, and that contemporary civilization could not exist without minerals and the mining industry.



William Murray of Amarco presents the communications platform.



John Paul of Amas contributes to debate.



Barbara Spillinger and Henry Dworshak are officers of AMC.



AMC President J. Allen Overton Jr. listens to advice from AMC Chairman Ralph Bailey.

December 26, 1984

RESCREEN & SQUARE HALFTONES

25

President's Message

'I did not mine only for what would be mine, but for everything I wanted to be yours.'

It was nearly a quarter of a century ago that I began my association with the American Mining Congress, and I look back upon the ensuing years with satisfaction and pride in what has been accomplished... with much fondness for the friendships that have been formed... with enormous admiration for the persons who constitute the mining industry of America and who provide its leadership... and with the sure knowledge that the past is but prologue and the future will be even more challenging.

In those earlier days, things were much simpler and easier than they are today.

The headquarters of the American Mining Congress was able to operate in our nation's capital with a staff and budget that would appear ludicrously small when compared with our present demands.

America in those days stood astride the world economy like a colossus.

The word "ecology" sent people scurrying for their dictionaries.

And when we talked about the government regulating anything, we usually meant the money supply.

How vastly different things are today.

Now we see much of the minerals industry in financial distress... we see it besieged by the government's regulations and unduly burdened by its taxes... castigated by opponents who are uninformed... bushwacked by foreign competitors who manage to elude the discipline of economic reality... and forced into a quick march by the rising tempo of the technological revolution.

I am asked often what we should do about these problems that beset our industry, and my answer is this: We should fight!

And we should serve notice here and now that we intend to fight!

We will fight those who say they can construct a great new society on American soil without the help of mining, because we are the ones who have to dig into the ground so that others can build on it.

We will fight the extremists and paid professionals of the environmental movement—whom I differentiate from the many people, including ourselves, who believe that

By J. Allen Overton Jr.

God's creation has to be nurtured while His bounty can be used in a balanced manner.

We will fight those who proclaim that as long as your cause seems right and your vision seems virtuous, it doesn't matter if your facts are wrong and your evidence is missing.

We will fight foreign competitors who seek to steal markets for their products with the help of government subsidies, and tell them that the mining industry of America gladly accepts free and fair reciprocal trade; but if they won't agree to a fair match, our government should toss them out of its ring.

We will fight those insincere politicians who claim to support a strong and economically viable domestic minerals industry, and then vote at every turn to undermine its well being.

Finally, let all of us pledge together to fight lethargy and stodginess in our own industry. Let us acknowledge that technological advances, the emergence of new materials and their uses, and the rapid growth of the service sector of the economy have combined to change dramatically the nature of the business.

Moreover, Mining involves non renewable resources. Every mine sooner or later comes to an end. Thus, the industry is constantly in the process of change. New reserves must be found by discovery or acquired by purchase or merger or, in time, a mining company will cease to exist.

This process of change... this meeting of challenge and the taking of chance is the nature of our business.

It is inevitable that there always will be a shaking up in this industry, and those who survive best will be those who adapt most.

They will be the ones who seek new mining properties... who aggressively seek new markets by studying the

needs of the customer... who develop new products and suggest new ways of using them... and who will innovate and initiate.

However, amidst all this change, what I hope will never alter is the magnificent support that members of this industry have given to the American Mining Congress.

Over the years, there has been an enormous expansion in the load of work we have undertaken, which has been in response to the expansion of governmental intervention into our affairs.

The growth of federal regulations has been stupendous and the number of agencies administering those regulations has proliferated.

The Congress has enacted more and more laws affecting our business, and those laws have been of greater and greater complexity.

We are involved in litigation of horrendous volume that nobody could have imagined a few short years ago.

And after every Congressional election and every newly elected Administration, hundreds of new officials and thousands of their new staff members descend upon Washington, and most of them know very little about mining and what is required to enhance this industry's service to society.

This means our educational duties are ceaseless and the task of establishing new and trusting relationships is endless.

In the performance of this work, the American Mining Congress has enjoyed the talents and dedication of staff members, both past and present, with whom I am privileged to serve.

But what we have valued most is the loyal support of our member companies, particularly during recent times when so many of them have experienced severe economic difficulties and have had to make painful adjustments within their own companies.

We at the headquarters of the American Mining Congress responded to these circumstances by imposing stringent economies of our own, and we have managed to make do by making ourselves do.

American Mining Congress Journal

J. Allen Overton Jr. is the president of the American Mining Congress. He delivered these remarks at the Opening Session, Sept. 23, at the AMC Mining Convention in Phoenix.



J. Allen Overton Jr., right, president of the American Mining Congress, confers with AMC Chairman Ralph E. Bailey, who also is chairman of Conoco Inc.

In this effort, we have been sustained by the faith of our members and by the shared belief that in unity there is strength.

In the mining industry today, as perhaps never before, the admonition of Benjamin Franklin holds true: Either we all hang together or most assuredly we shall hang separately.

I could not possibly describe in all the terms it merits how well this alliance of common interest that is the American Mining Congress has been served by the leaders of its member companies.

We truly have been blessed, in the past and the present, with leaders of remarkable character, ability, devotion and integrity. Frankly, one of the signal honors and profound pleasures of my life is the privilege to work with them and to work for them.

On repeated occasions I have seen members of the AMC Board of Directors, their Chairmen, the Finance Committee Chairmen, the members of the Finance Committee and many other chief and senior officers of our member companies volunteer to undertake the most arduous tasks for the benefit of the industry.

Constantly I must remind myself that these are persons with heavy schedules and taxing obligations within their own companies, and I am awed by the spirit, the resourcefulness and the dedicated energy they still manage to bring to the additional labors for which they have offered themselves gladly.

They are in the great tradition of mining in the United States of America. They are men not of narrow minds, but of broad vision... not content to hope for the best, but willing to work for it... not wanting always to play it safe, but daring to take risks... not forever with the focus on self and the countinghouse, but on service and country.

There is not one company in this

industry or perhaps in any industry that could hope to command the array of abilities that these leaders have volunteered to put at the disposal of us all.

If one stops to think about it, I believe he would agree with me that those who pay their dues to the American Mining Congress are amply getting their due.

All of us also should have the deepest respect and gratitude for the manufacturing companies, whose manifold contributions are an integral and essential part of our endeavors.

They are not only key to the success of our shows and exhibitions, but without their competence to create the sinews of our capacity to mine the treasure trove of the earth, this industry would not keep its rank as the most safe and efficient producer and processor of minerals in the world.

And without their indispensable participation, the mosaic of unity and purpose that gives shape to our organization would not exist.

In addition, there are scores and scores of persons who serve long hours on AMC's many technical, advisory and policy groups and they contribute tremendously to the case that we carry to public forums and to the government.

Perhaps only those who know their work intimately can appreciate it fully, but all of us who benefit from that work should acknowledge our gratitude.

Yet, grateful as we are to these many men and women, they and the American Mining Congress cannot carry the necessary battle alone.

We confront formidable obstacles that have their underpinnings in politics, where they are strengthened by the fanatics who lead a highly organized, well financed, broadly based and vocal lobby of citizens who share

our concern for the environment but are misled into carrying that concern to an unnecessary extreme.

When I say our industry must fight, I mean it must fight this opposition on its home ground, which is not Washington, D.C., but every part of this vast country where those who come to Washington must first go to get elected.

Let us remember that we carry a compelling case.

Without mining this nation would not have won its birthright in the War of Independence... it would not have held firm in the War Between the States... it would not have been the arsenal of freedom that endeavored to make the world safe for democracy in World War I or kept it free in World War II... nor would it stand today as the bastion of liberty around the globe.

Without minerals, shattered societies could not have been rebuilt after the devastation of conflict, the material blessings of life would be meager, and the aspirations of mankind would be forever beyond reach.

This great industry of ours provides the "stuff" from which things are made, and it is miners who dig the hole from which the horn of plenty flows.

We have put our lives and treasure into providing the goods of life, and we can be proud to do so today with a heightened regard for the environment... a paramount respect for the health and safety of those who work with us... and the knowledge foremost in our minds that mining is meant to serve society.

And serve it, it has. Whenever the call to arms has sounded, the mining industry has jumped to the front lines, and whenever peace has brought on more material wants, the mining industry has geared up to meet them.

So it is sad today to reflect that this industry of ours that has always sought to be first in war and first in peace is so often last in the thoughts of our countrymen.

But we can fight and work to change that, and we can do it with the proud knowledge that we carry on a noble calling.

And if we do it with all the thought and care and compassion and intelligence and integrity we can muster, then we can say to our posterity: I did not mine only for what would be mine, but for everything I wanted to be yours.

This is the American Mining Congress

Articles of Incorporation of the American Mining Congress

"The name of this corporation is and shall be American Mining Congress

"The objects and purposes for which this corporation is formed are:

- "1. To foster, promote and develop the general welfare of the minerals industries in all their various branches within the United States;
- "2. To cooperate with government in furthering the national welfare and in developing mining and metallurgy;
- "3. To encourage and provide a medium for education in practical and scientific mining and metallurgy; and
- "4. To encourage and promote, and assist the minerals industry in the development of the means for detecting, eliminating and preventing the causes of illness and injury among the industry's employees."

Acting in Concert

Since the late nineteenth century, the American Mining Congress has advanced the cause of the mining industry—both as an advocate of the industry's positions and as a promoter of improved mining knowledge and practices.

Its accomplishments have been due primarily to the vigorous role played by its members—companies of all sizes throughout the country

If all elements of the mining industry are to grow and prosper, they must continue to act in concert to assure that their interests are continually advanced and serve the broad interests of society. Your company's participation in the American Mining Congress will promote its well being and that of this entire bedrock industry of our great nation.

Conventions and Expositions

AMC sponsors two major conventions each year—a coal convention in the spring and a mining convention in the fall.

Every other year there is an exposition either at the coal or the mining convention. At the 1984 International Coal Show in Chicago, for example, over 400 exhibitors used more than 300,000 square feet to display everything from cap lamps to crushers, ore cars to huge excavators and blasthole rigs to jumbos. The next International Mining Show will be held in 1986 in Las Vegas.

Convention sessions cover a wide range of matters involving congressional and executive branch policies and programs that affect mining and the latest mining techniques, technology and equipment.

Developing Industry Expertise

AMC holds workshops and seminars throughout the country on a variety of subjects. In recent years, these have included mine safety and health, coal surface mining, risk assessment, international

trade, and equipment approval procedures. There's an annual Tax Workshop and also a Financial Conference—a forum to examine financial developments affecting the mining industry. A Communications Workshop helps develop skills of mining industry personnel.

Coordinator of Action

The American Mining Congress is both a coordinator of action and a clearinghouse for information in behalf of the mining industry in the nation's capital.

As spokesman for the industry since 1897, AMC advocates measures that will promote the development of mineral resources that are vital to the nation's security and the well being of its people. Among its areas of continuing concern are governmental regulation, taxation, environmental policies, public land use, safety and health, surface mining and reclamation, minerals availability, industrial relations, international trade, and national stockpile policy. It is an advocate of policies to increase the efficient use of domestic energy resources and to develop relevant new technologies.

AMC keeps its members informed on developments in the executive, legislative, and judicial branches of the federal government.

In short, AMC is the mining industry's eyes and ears—and its collective voice—in Washington.

In addition, the American Mining Congress is in the vanguard in improving mining practices and equipment and in marshaling the cooperative endeavors of mine operators and equipment manufacturers in the interest of health, safety, and efficiency. Its technical committees (comprised of operators and manufacturers), its publications, its conventions and expositions all contribute to this effort.

AMC's members include (1) producers of most of America's metals, coal, industrial and agricultural minerals, (2) manufacturers of mining and mineral processing machinery, equipment, and supplies, and (3) engineering and consulting firms and financial institutions that serve the mining industry.

Members Set Policy

The members of the American Mining Congress determine policy.

There is an annual meeting usually held in Washington in late January or early February. Vacancies on the Board of Directors, which has up to 44 members, are filled by vote of the membership at the annual meeting. There's an Executive Committee of the board, and the board appoints other committees and subcommittees.

Each year a Committee on Resolutions is appointed, and this committee recommends resolutions on national issues of importance to the mining industry. On the basis of these recommendations, the board then adopts an annual Declaration of Policy.

The many committees of AMC pursue the objectives set forth in

the Declaration of Policy. The committees have a major role in presenting AMC positions at Congressional hearings and in guiding the staff in its work with the legislative, executive, and judicial branches of government.

Manufacturers Play Key Role

The AMC Manufacturers Division, which was organized in 1922, promotes the mining industry through the mutual cooperation of the manufacturers of mining equipment and those engaged in mineral production. The division is an integral part of the American Mining Congress and is represented on the Board of Directors by five members.

Its activities aid the mining industry by disseminating operating and technical information, promoting continued progress in the use of machinery, equipment and supplies, and developing improved mining methods and practices. The Manufacturers Division has a major role in AMC conventions and expositions in presenting papers and exhibiting equipment.

The division advocates policies of benefit to the industry throughout the legislative and executive branches of the federal government. Areas covered include product liability, technical standards and regulations, governmental approvals and

certifications and export-import problems and opportunities.

Keeping Up to Date

Members stay abreast of Washington news and developments in mining through a variety of AMC communications and publications including the *American Mining Congress Journal*. The *Journal* was totally redesigned in 1983. The editorial emphasis was shifted from technical developments to current news and features affecting the mining industry. During 1984, the *Journal* received two awards from the International Association of Business Communicators. The weekly publication *Washington Concentrates* helps keep top company officials informed on an even more timely basis.

In addition, the AMC produced, award winning film and slide show take the mining message to the general public. Brochures, such as "The Resources War," are produced from time to time.

Another member service is AMC's library, which has been expanding to meet the increased demand for information. The library collection of 4000 books and reports and 250 periodicals reflects the scope of Mining Congress activities. Descriptions of each item in the collection are being entered into the AMC computer data base, and can be accessed by author or keyword.



AMERICAN MINING CONGRESS

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Mr. REID. The next witness that we're going to call is Dr. Joseph Crowley who is accompanied today by Dr. Read Holland. I'm proud to note that Dr. Crowley is the president of the University of Nevada at Reno and a friend of long standing with myself and one of Nevada's prominent citizens who has rendered great service to the State of Nevada. He is accompanied, as I mentioned, by Dr. Read Holland who is director of the School of Mines and Energy Development for the University of Alabama in Tuscaloosa, AL. Gentlemen, we appreciate your being here.

Dr. Crowley, we have your written statement. If you would, please give us an outline of that statement so we have time to ask you questions.

STATEMENT OF DR. JOSEPH CROWLEY, PRESIDENT, UNIVERSITY OF NEVADA AT RENO, RENO, NV

Dr. CROWLEY. Thank you, Mr. Chairman. I would be delighted to do that. I would like to note for the record that Dr. Holland and I are here this morning on behalf of the Mineral Resources Committee of the National Association of State Universities and Land Grant Colleges. I chair that committee. I am not an expert in the area of mineral resources but I chair a committee of experts that Dr. Holland is one and he will be helping me a great deal this morning.

We also speak for the National Association of Mineral Institute Directors and, again, Dr. Holland is a member of that as well.

Of course, our principal interest is in the State mineral institutes which have become a very significant element in research and development for the minerals community and the production provision of trained manpower for the minerals industry.

We know that this subcommittee has a major interest in the National Critical Materials Act of 1984. Our testimony does address the institute program in the context of that legislation. State mineral institutes are quite well versed in mineral processing which is analogous to material processing. It seems clear that the maintenance of healthy domestic mineral industry is dependent on continued advances in mineral processing. If such advances do not occur as has been noted, we're looking at increased dependence on foreign mineral resources and that kind of dependence is obviously not healthy in terms of national security.

There are two activities of the Bureau of Mines in minerals and materials research and in the State mineral institutes that are of particular importance to the establishment of a national program for advanced materials research and technology. These two activities of the bureau we think merit vigorous support. It seems difficult to reconcile the Department of the Interior budget request of a considerable reduction of 28 percent in minerals and materials research and even more considerable reduction in the State minerals institutes. It is difficult to reconcile that with the national need which has been eloquently testified to by the previous spokesman.

We believe that the minerals and materials research in the bureau should be restored to 1985 budget levels. We agree with the recommendation of the Interior Subcommittee on Mining and Natural Resources. That subcommittee recommended that the institute

program be supported at the authorized level of \$24,400,000. We regard this as certainly the optimal level and a justifiable level. However, we do recognize the constraints under which you work.

We have previously recommended to the appropriations subcommittee that a minimum of \$12,500,000 should be appropriated. This does represent a current services budget based on the 1984 mineral institute appropriation together with additional funding to support the Generic Center for Respirable Dust which was created by Congress in 1983.

As I'm sure you're aware, Mr. Chairman, the Mineral Institute Program is operated through 31 State institutes. Each of these institutes receives an equal amount of allotment grant funds. These are subject to State matching requirements and the institutes use these funds for the purposes of research and to support students.

The Generic Research Program operates through five generic mineral technology centers. These are located at the State institutes. There is a lead center and a number of affiliate institutes numbering from three to six. There is a center at VPI that focuses on mine system design and control. There is a center at the University of Utah; a center at my own university which focuses on mineral industry waste treatment and recovery and centers at the University of Missouri at Rolla and the center jointly operated by Penn State and West Virginia.

We submitted last year in our reauthorization testimony a 5-year record of achievements of the Mineral Institute's Program. That record is submitted for the record of this subcommittee hearing, as well. That 5-year record includes considerable number of research projects averaging about 200 a year and considerable support for students, as well, and also notes what kinds of industry support has been forthcoming and the nature of the impacts of research at those 31 institutes over the period of 5 years.

Also submitted for the record, an update that took the program through 1972. We have updated for the record the last 2 years of accomplishments and those accomplishments, we think, have been considerable both for the institutes and for the generic centers.

Mr. REID. Miss Reporter, do you have those documents he refers to?

The REPORTER. No, sir, I do not.

Dr. CROWLEY. I'm sorry, Mr. Chairman. It was my understanding that the Land Grant Association would submit them for the record.

Mr. REID. We don't have those so that will have to be supplied. Otherwise, it won't be part of the record.

Dr. CROWLEY. I would hope that we would have some time to get them in, Mr. Chairman.

Mr. REID. We'll keep the record open to allow you time to do that.

[The documents referred to follow:]

**Increasing Supply & Productivity
in the Mineral Sector through Research & Education**

**A Five Year Record of Achievement
(1978 - 1982)**

by

**The Mining and Mineral Resources
Research Institutes**

December, 1983
Washington, D.C.

Dr. Kenneth J. Reid, Director, Mineral Resources Research Center
University of Minnesota, and Chairman,
National Association of Mineral Institute Directors

Dr. Joseph N. Crowley, President University of Nevada, Reno
and Chairman, Mineral Resources Committee
National Association of State Universities and Land-Grant Colleges

Introduction

The purpose of this report is to provide information to the Congress, the industry, and the Federal government on the accomplishments of the Institutes during the first five years of the Mineral Institute programs. For the program to continue, it must be reauthorized by the Congress prior to the late spring of 1984, and this report will serve to provide background information for that action.

The need for this report was conceived in 1982 by the Mineral Resources Committee of NASULGC, chaired by President Jay Barton, of the University of Alaska. It was assembled by a group of Directors, led by Dr. Dayne Aldridge, West Virginia University, Chairman of the National Association of Mineral Institute Directors 1983, who prepared the original draft.

It is based on information supplied by the Directors of the thirty-one Mining and Mineral Resources Research Institutes in early 1983. The names and addresses of the directors are included in each of the State Institute Profiles within this report.

The report was printed by the American Mining Congress, through the courtesy of the Mining Education Committee, chaired by Jack Thompson, President of Newmont Mining Corporation. This Committee has been working closely with the NASULGC Mineral Resources Committee for the last several years.

Background

Mining and Mineral Resources Research Institutes have now been established in 31 states as authorized by Title III of Public Law 95-87 signed August 3, 1977. The purpose of this act is to:

"stimulate, sponsor, provide for and/or supplement present programs for the conduct of research investigations . . . in exploration, extraction, processing, development, and production of minerals, and the training of mineral engineers and scientists in the field of mining, minerals resources, and technology, and the establishment of an appropriate research and training center in the various states . . ."

The establishment of the Institutes was the outcome of a long-standing concern in the engineering and scientific community. As noted in the report of the National Academy of Sciences in 1969:

"We are alarmed that mineral engineering programs in universities receive so little financial support, a particular consequence of which is the deteriorated state of higher education in these fields in the United States. We also find an amazing lack of coordination and support of mineral resource research by both federal and state governments as compared with the organization and funding of research on agricultural resources. We find that domestic mineral production as a percentage of the gross national product has fallen off steadily from about 4 percent a decade ago to a present level of about 3 percent, while during the same period the increase in the net value of mineral imports over exports has tripled. The country is not running out of mineral resources but out of mineral technology needed for their profitable production and processing in world competition.

The United States must change this trend by invigorating mineral engineering education and research to provide the human resources and the knowledge that alone can prevent an impending serious loss in the country's competitive position in mineral technology. The U.S. Bureau of Mines must be provided with strong, stable leadership, and this Bureau along with the U.S. Geological Survey should be provided with funds to carry out needed comprehensive research programs (in cooperation with universities, state agencies, and industry) on the science and technology related to our mineral resources."*

*National Academy of Sciences-National Academy of Engineering, 1969, Mineral Science and Technology: Needs, Challenges and Opportunities. Committee on Mineral Science and Technology.

More recently, in a 1980 report on U.S. Minerals Vulnerability,* the House Committee on Interior and Insular Affairs, Subcommittee on Mines and Mining urged "... Federal departments and agencies to recognize and act upon minerals problems before crisis situations develop." Among the recommendations in the report are these concerning research and development:

"Federal mineral supply research and development should be significantly increased to reestablish United States leadership in technological innovation and to improve recovery and productivity in the minerals sector.

Increased levels of support should be provided colleges and universities engaged in extractive technologies research.

A program should be devised for government to more effectively contribute to demonstration projects to prove new technologies.

The 31 Mineral Institutes established by the Department of the Interior at colleges and universities should be transferred to the Bureau of Mines to improve mineral supply research and development cooperation."

The nation's industrial leadership recognizes and supports research and development leading to the new technologies that are essential to the continuing health and competitive position of the mining industry. For example, David Swan, Vice President of Kennecott Corp in his testimony to a Congressional hearing in 1981 noted that:

"... with respect to the mining sector, the U.S. appears to be maintaining its preeminent position in the development of mining technology. The tangible benefits of innovation in an industrial society are most clearly shown by improvement of manpower and capital productivity. Thanks to a vigorous U.S. effort, American mining productivity in the nonfuel mineral area continues to show substantial improvement despite a slowdown in recent years."

Donald H. Trautlein, Chairman of Bethlehem Steel Corporation, has emphasized that the development of high-quality human resources is the critical factor in our global economic competition. Speaking before the National Press Club on May 5, 1983, he said:

"To compete with the best, you must have the best - the best equipment, the most advanced technology, the most sophisticated techniques and methods - and I think, most importantly, the best-trained people - not by U.S. standards but by world standards!"

*U.S. Minerals Vulnerability: National Policy Implications." Subcommittee on Mines and Mining, Committee on Interior and Insular Affairs. U.S. House of Representatives, November 1980, page 83.

Summary

The Mining and Minerals Resource Research Institute (MMRRI) program was initiated on September 30, 1978 with 20 institutes and grew to 31 by 1980. The purpose of this federal program was to stimulate research and training of engineers and scientists in mining and minerals resources and technology through the establishment of mining and mineral resource research institutes in states meeting basic qualification criteria.

Despite the relatively short life of the MMRRI program, research conducted under its sponsorship is already yielding practical results and having a positive impact on the nation's mining and minerals industry. Projects involving industry support including field testing and demonstration as well as routine use of research results clearly show the existing and potential industrial impact of this modest sized federal program.

The long term health of the mining and minerals industry in the United States depends on vigorous research activities at institutions of higher education. The stimulation of an average of 234 research projects each year by the allotment program is helping assure future industry vitality by providing research results and student experiences that would not otherwise occur.

Since the inception of the MMRRI program production of advanced degrees production in the mining and minerals disciplines in the United States has shown a 5-6 fold increase in masters degrees and a 3-4 fold increase in doctoral degrees. It is believed that the MMRRI program played a major if not key role in causing this increase since the allotment and scholarship/fellowship programs provided support for a total of 319 undergraduate students and 423 graduate students per year on the average. In addition, 123 students have received support through separately funded research projects.

While the nationwide impact on mining and minerals education is of major significance, the current output of graduates with advanced degrees in Mineral Engineering disciplines is clearly inadequate. The average annual production of 30 PhD's for all extractive minerals disciplines for the whole nation cannot meet the need of new faculty in higher education, much less that of industry and government.

The state Mineral Institutes have benefited from industrial support for both research and instructional activities. Data gathered from the Institutes show a significant level of support for scholarships and assistantships. While access to property and equipment for instructional and research purposes has been provided, direct support for research has been less intense. It is clear that the nation's mining and mineral academic programs interact with industry in ways that complement the mission of the Institute program.

Auxiliary impacts of the MMRRI program include increased continuing education opportunities for industry and improved faculty support. An annual average of 191 faculty received partial or full support through the allotment program helping address an acute instructional problem for mining and mineral academic programs across the nation.

Research: Providing Practical Results

The long term health of the mining and minerals industry in the United States depends upon research and development activities that will provide new information and will lead to new technologies.

Academic institutions are major performers of R&D, and it is critical that the nation maintain vigorous research activities at institutions of higher education. A major purpose of the Institute program is to stimulate research in academic settings.

During the first five years, the Institutes have provided a significant stimulation of research activity. On the average, the Institutes have supported 194 projects each year on a wide variety of mining and mineral topics, throughout the United States. These are research activities that would not otherwise have existed. The program has also contributed over \$2.5 million for equipment purchases in support of minerals research.

These activities have already yielded practical results that are having a positive impact on the nation's mining and minerals industry. It would be difficult to estimate the total economic benefit of these accomplishments. But the variety of minerals, the breadth of mining conditions, and the large number of private companies involved, all indicate that the program is having a wide range of impacts.

Here are some examples of the impacts of Institute research:

As a result of research in Alabama on impounded fine coal wastes, fine coal is now being removed by three companies from their waste impoundments and put to profitable use. Plans are underway by several other companies to do likewise.

A system using hydrocyclones was developed for recovery of fine placer gold. Potential users include 450 active placer mines in Alaska.

A complete crystal structure refinement of a kaolinite has been achieved for the first time in Georgia. This leads to the production of a zeolite with an industrial potential of 500 million dollars.

Iowa researchers have found that electroosmosis can be used to enhance the dewatering of coal sludges and suspensions, mill tailings, etc., for recovering useful fuels and minerals from waste products. Tests for possible commercialization are now underway.

Research in Kentucky has yielded methods being used by industry for predicting the effect of mining on an area's hydrology and sedimentology.

Pilot scale and industrial demonstrations have met with success by Michigan researchers on equipment to monitor the ash content of coal using direct on-stream sensors in coal processing plants.

The Mississippi MMRI delineated 3.3 billion tons of lignite within 300 feet of the surface in Lauderdale County.

Procedures have been developed in Montana for using vibrated high-modulus fills in underground mines. Field testing is underway in the Coeur D'Alene district with economic and safety impacts judged as favorable.

Studies in Pennsylvania have resulted in a major technological process innovation that involves a combination of calcination and sintering phenomena into a single step in the processing of dolomite for refractory applications. This provides a production adaptable process that is both cost and time effective.

Research funded through the Texas MMRI has pointed to four regions of high potential for deep recovery of lignite.

New methods for mitigating acid mine drainage problems have been discovered and developed in West Virginia. Through the cooperative efforts of the MMRI, state agencies and industry, field tests are now underway or already in routine use.

The advances in mineral science and technology made possible by MMRI sponsorship serve to foster the initiation of new industrial activity and the improvement of present industrial practice. Further examples of research which has been particularly significant in this regard are included in the State Institute Profiles, later in this report.

Education: Training Quality Engineers and Scientists

Programs which produce degrees in mining and minerals disciplines are the foundation of the Mineral Institute program. There has been national concern over the low production of advanced degrees in science and engineering and especially in the mining and minerals areas. This is not only important to the general health of the nation's minerals' industry but also to the health of the related academic programs.

Data gathered on degree production in minerals related academic disciplines indicates that there has been a significant increase in the production of graduate degrees. The Mineral Institute program has played a major role in this increase. The combined production of the extractive fields increased from 34 to 189 at the masters level and from 11 to 31 for doctorates over the 1978 to 1982 time frame with a high of 46 doctorates graduated in 1981. Data are shown in Table I.

Table 2 shows that the allotment program (under Section 301) has provided support for 99 undergraduates and 185 graduate students each year on the average. Similarly, funds provided for scholarships and assistantships under Section 302 provided support for 220 undergraduates and 238 graduate students per year on the average. Furthermore, research projects under section 302 showed support for 123 students per year. Support for an annual average of 16 post doctorates is also indicated.

The nationwide impact on graduate level mining and minerals education is of major significance. However, the production rate of advanced degrees is clearly inadequate. Table I shows that for the entire United States only 30

TABLE I
Advanced Degree Production in Minerals Related Disciplines

Discipline	1978		1979		1980		1981		1982		Totals	
	MS	PhD	MS	PhD	MS	PhD	MS	PhD	MS	PhD	MS	PhD
Mining Engineering	8	2	37	3	37	6	41	8	66	5	189	24
Mineral Engineering	1	0	11	2	8	0	8	4	3	3	31	9
Geological Engineering	10	2	35	2	27	2	35	7	27	4	134	17
Metallurgical Engineering	11	6	41	17	33	7	44	16	57	15	186	61
Min. Proc. Engineering	0	0	5	7	6	1	9	2	13	1	33	11
Metallurgy	1	1	7	5	16	4	19	8	11	3	54	21
Mineral Economics	3	0	14	6	7	1	11	1	12	0	47	8
	34	11	150	42	134	21	167	46	189	31	674	151

TABLE 2

Mineral Institute Activity Supported by PL95-87

1978 - 1982

(Average per Year)

Research Projects	234
Faculty Support	191
Student Support	
Undergraduate	
Research Projects	99
Scholarships	220
Graduate	
Research Projects	185
Assistantships	238
Post Doctoral	
Research Projects	4
Fellowships	12
Value of Equipment	\$2.5 million

PhD's per year were produced in all extractive minerals disciplines. In mining and minerals engineering alone less than 7 PhD's are being produced per year. These levels of production cannot meet the needs of higher education, much less those of industry and government.

The Industrial Role: A Critical Involvement

The state Mineral Institutes have benefited from industrial support for both research and instructional activities. Data gathered from the Institutes show significant levels of support for scholarships and assistantships, in some States more than \$100,000 per year. While access to property and equipment for instructional and research purposes has been provided, direct support for research purposes has been less intense.

Although it is not possible with these data to assess the sufficiency of direct industrial support for the Institutes, the data do show that the nation's mining and mineral academic programs interact with industry in ways that complement the mission of the Institute program. Companies that provide direct or complementary support are listed in the State Profiles that accompany this report. Of the 27 institutes reporting industrial support, the number of separate industrial participants per institute averaged 15.

Here are examples of industrial involvement:

- | | |
|-----------|--|
| Alabama | - Research on beneficiation of Eastern Devonian Oil Shales to recover upgraded products; Phillips Petroleum Company. |
| Alaska | - Analysis for recoverable gold in drill hole samples; Livengood Joint Venture. |
| Illinois | - Direct support for a wide range of projects plus access to mining properties to perform reclamation research. |
| Iowa | - Numerous projects relating mostly to coal cleaning. |
| Kentucky | - At least 45 companies support research involving oil shale, coal liquefaction, fluidized bed combustion and reclamation. |
| Louisiana | - Six major oil companies support the blow-out training center and associated research. |
| Michigan | - Direct industrial support for several research projects in mining, metallurgical and geological engineering. |
| Minnesota | - Post doctoral fellow worked summer 1981 at the Hanna Mining Company's research center collecting data for a study on grinding efficiency and control of a plant grinding mill. |
| Missouri | - Direct support of projects involving metallurgy, refractory technology, explosives and mining and mineral processing topics. |
| Montana | - Full support of research concerning tailing ponds for Anaconda Smelter and Butte mining operations at Warm Springs. |
| Nevada | - Partial support for research on the fundamental chemistry and recovery of gold from carbonaceous ore bodies; Exxon and Westvaco. |

- North Dakota - Investigation of the subsidence and surface collapse features in reclaimed surface coal mine spoils.
- Oklahoma - Qualitative and quantitative analysis of iron-bearing minerals in fossil fuels and petroleum source rocks.
- South Dakota - Partial support development of rapid testing methods for coal and coal bearing rocks and study of special blasting techniques.
- Utah - Partial support for development of air sparged hydrocyclone and for research involving monitoring of mine waste dumps, grinding and flotation circuit simulation and use of coal wastes to produce alumina.
- Virginia - Research on the application of image processing for the beneficiation of fine grained complex sulfide ores has led to full industrial support for using the procedures to study carbonates.
- West Virginia - Full support for numerous projects involving roof control, multiple seam mining, shortwall and longwall mining, fly ash utilization, mine reclamation and coal processing as well as access to surface and underground mines to gather data and perform experiments.

Conclusions

From the data presented herein it is apparent that the Mineral Institute program has made a significant national impact in accordance with the purpose of the authorizing legislation. Without question minerals research has been stimulated in a wide range of topics of national and regional concern and results of this research are already having industrial impact. Students have been attracted to study in these areas and advance degree production appears to have been increased markedly by the program. Industrial linkages to minerals academic programs are in place.

There has been increasing concern over inadequate support for faculty in science and engineering schools across the nation. Mining and mineral programs present some of the most acute problems of this type.

The wide range of benefits is summarized in the State Profiles. Special note should be made of increased continuing education opportunities for industry along with the improved research and instruction facilities including upgraded laboratories. During a time of rapid growth of science and engineering enrollment and reduced state support for higher education, the MMRRRI program has provided a critical factor on a national scale for mining and minerals academic programs.

An inadequate supply of qualified faculty, poorly equipped laboratories, etc. are all factors for which the minerals programs must compete for resources within each institution. Thus the 191 faculty (average per year) that have received full or partial support through the MMRRRI allotment program has been an important contribution. Although the Mineral Institute program has directed some resources to these problems, the needs continue to exist as does the need for a national base for exploratory research in mining and minerals.

Alabama - Institute Profile
(1978-82)

Director R. Bruce Tipten
Mining and Mineral Resources Research Institute
School of Mines and Energy Development
University of Alabama
University, Alabama 35486

Activities (average number per year):

Research projects	14
Faculty support	14
Student support	
Undergraduate	8
Graduate	6

<u>Total Value of Equipment Purchased</u>	\$182,117
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<u>Industrial Support for scholarships, fellowships and assistantships</u>	\$79,000
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Industrial Impacts:

1. Reconnaissance and Processing of Impounded Fine Coal Wastes

Forty impoundments at 20 sites in the state were sampled and mapped. As a result, fine coal now is being recovered by three companies from their waste impoundments and plans are underway by several other companies to do likewise.

2. Coalbed Methane in Alabama

Four test coreholes, funded by the U.S. Department of Energy, have been drilled to depths of 2800 to 3400 feet. A total of about 200 million cubic feet of gas is potentially available from each forty acre tract in a large portion of the research area. A demonstration well, funded in part by the American Public Gas Association, has been completed on the University campus.

Other Beneficial Impacts:

The Institute provided instructional assistance to the Department of Mineral, Geology and Chemical/Metallurgical Engineering, student employment and equipment purchases in virtually all parts of the university. The publication of results from Institute research on mineral-related activities were important service functions of the Institute. Workshops, symposia, conferences, and short courses were conducted on mineral and energy subjects. Attendance was from 100 to 200.

Assistance in solving difficult research and development problems was provided to industry. For example, research studying the impact of surface coal mine blasting on contiguous underground operations proved that surface mine blasting, when properly conducted, could be carried out safely in closer proximity to underground operations than allowed by law. Based on the Institute research, the U.S. Office of Surface Mining granted a waiver to the operators permitting a closer blasting scale distance thereby substantially increasing coal production capacity. It is estimated that the modified regulations will permit the recovery of about 20 million tons of coal worth about \$500 million which previously was not mineable.

Alaska - Institute Profile
(1978-82)

Director Nolan Aughenbaugh
School of Mineral Industry
University of Alaska at Fairbanks
Fairbanks, Alaska 99701

Activities (average number per year):

Research projects	5
Faculty support	5
Student support	
Undergraduate	24
Graduate	9

Total Value of Equipment Purchased: \$49,246

Industrial Impacts:

1. Investigation of Mercury-Antimony-Tungsten Metal Provinces in Alaska

Reexamination of Alaskan deposits indicated that Alaskan mercury-antimony-tungsten should be reevaluated within a stratabound framework. Exploration activity for tungsten in Alaska increased dramatically since the 1979 release of these research results.

2. Application of Hydrocyclones for Recovery of Fine Gold from Placer Material

A system using hydrocyclones was developed and found to be practical in recovery of fine placer gold. The system is designed to be easily disassembled and moved for field installation. Potential users include not only the 450 active placer miners in Alaska but also placer miners worldwide.

Other Beneficial Impacts:

MIRL provides a mining information program in Interior and Central Alaska. A newly constructed 2,000 square foot facility is to be used to display reports, maps, and rocks for the mining community, interested members of the public, and local students. The professional staff and faculty of the School of Mineral Industry pay an annual visit to all high schools accessible by road to deliver talks on the importance of mines and minerals in today's society. Initiated annual Placer conference (1978) with MMRPI funding. Three day MIRL conference (1980) with 600 attendees.

Arizona - Institute Profile
(1978-82)

Director Orlo E. Childs
University of Arizona - MMRI
Room 17A - Arid Lands Bldg.
845 N. Park Avenue
Tucson, Arizona 85719

Activities (average number per year):

	Research projects	4	Student support	
	Faculty support	5	Undergraduate	3
			Graduate	12
Post Doctoral	1			

Total Value of Equipment Purchased \$107,434

Industrial Support for scholarships,
fellowships and assistantships \$235,000 per year

Industrial Impacts:

1. Smelter Emission Controls: The Impact on Mining and the Market for Acid

The economic impact of sulphuric acid production at copper smelters was studied. Wide industrial and governmental distribution of the final report has aided in pointing to problems that may result in closing five smelters.

2. Inventory and Hazards Monitoring of Mineral Lands Using Satellite Imagery and Collateral Data

Remote sensing used to assess the environmental hazards of mining operations in Arizona provides an expansive and useful approach to the monitoring of public safety in terms of hazards that must be planned for in continued industrial operations.

Other Beneficial Impacts:

The Arizona Mining Association is directed by Officers of eighteen major Mining Companies, many of whom have headquarters outside the state. A Special Research Report series has been established by the AZ-MMRI and these reports are distributed to companies through the offices of the Board of Directors of the Association. To date, eight reports have been distributed, and special re-orders have been filled sending the results of research at the University of Arizona throughout the industry, insuring that research activities, and faculty strengths are known within the state and nation.

A special grant of \$30,000 was given by the Arizona Mining Association to the College of Mines in support of research at the Dean's direction. These funds made it possible to provide security and reduced operation of a large multi-million dollar research pilot plant given by Univeral Oil Products to the University in support of the College of Mines. This entire facility has been leased to Cimetta Engineering Company with the AZ-MMRI acting as intermediary to assure research accessibility by faculty and students of the University.

California - Institute Profile
(1978-82)

Director Douglas W. Fuerstenau
University of California
Hearst Mining Building
Berkeley, California 94720

Activities (average number per year)

Research projects	8	Student support	
Faculty support	6	Undergraduate	4
		Graduate	7
		Post doctorals	1

Total value of equipment purchased: \$133,700

Industrial support for scholarships,
fellowships and assistantships: \$329,000 per year

Industrial Impacts:

1. In-Situ Stress in Relation to Mine Stability--Analysis of Keyblocks

This research analyzes conditions for stability of fractured rock mass, which is of concern when an excavation is made into a jointed or fractured rock. In some cases, the movement of one block (the key block) loosens several more behind it so that collapse follows initial rock movements. Procedures have been developed for finding the keyblocks which are central to the stability of the whole excavation. Rigorous, complete, and immediately usable methods have been developed to find all the keyblocks for a surface or underground excavation of virtually any shape. We have demonstrated that it is possible to predict either more-stable-and-less-dangerous or more-ready-to-cave configurations, whichever is preferred.

2. Fluidized Bed Electrowinning of Metals

Fluidized bed electrowinning of metals appears to offer the opportunity for substantially lowering the capital cost of the hydrometallurgical route to copper, nickel and other metals. The implementation of this new technology appears to have been hindered by the fact that most previous investigators of fluidized bed electrodes have encountered cell voltages (electrical energy consumptions) that were much higher than those of conventional electrowinning. The cause of such energy consumptions has been high electrical potentials in the anode side of the cell. Research at Berkeley has led to the development of novel anodes that are free of such excessive energy consumptions, thereby paving the way for commercial development of this improved technology.

Other Beneficial Impacts:

The sharply growing mining activities in California add to the responsibilities of the MMRI and reinforce its importance to the State. The Berkeley Campus has long had a diverse program in various mineral engineering fields and the Institute has helped provide a focus for faculty teaching and research in these fields. A newly organized mineral engineering curriculum has received full ABET accreditation. The University of California at Berkeley is generally considered to be the overall premiere graduate institution in the United States, and the California MMRI has influenced the strengthening of Berkeley's graduate mineral engineering program. Berkeley contributes immensely to publications and symposia in mineral engineering. New faculty in several other colleges and universities received their Ph.D. degrees recently from Berkeley mineral engineering programs.

Colorado - Institute Profile
(1978-82)

Director Joseph C. Weber
Assistant Dean for Research Development
Colorado School of Mines
Golden, Colorado 80401

Activities (average number per year):

Research projects	11
Faculty support	12
Student support	
Undergraduate	2
Graduate	9

Total value of equipment purchased: \$16,000

Industrial support for scholarships,
fellowships and assistantships: \$90,000 per year

Industrial Impacts:

1. Coal Dust Control by Condensation Enlargement

The objectives of the research were to design, construct, and evaluate a prototype dust conditioning system based on the concept of condensation enlargement. (Funds by NIOSH, CSM, and industry.)

2. Mineral Beneficiation and Extractive Metallurgy

The overall research program is related to the applications of surface chemical principles to mineral beneficiation and extractive metallurgy. Current development efforts include the following: (1) control of critical surface tension of wetting in flotation; (2) the surface chemistry of particles finer than 50 microns, obtained at controlled temperature; (3) filtration and dewatering of coal fines; (4) beneficiation of oil shale prior to retorting; and (5) non-bauxitic alumina and low-grade chrome-ore beneficiation. (Funds by CSM and industry.)

Other Beneficial Impacts:

The Mineral Institute is an integral part of CSM's program for Graduate Studies and Research and has demonstrated its effectiveness in developing and conducting research and the training of engineers and scientists. In a more recent year (1982-83), over 130 graduate degrees in mineral science and engineering related fields were awarded.

In a \$5-6 million research program, the largest single sponsor group is private industry which accounts for over 25 percent of the award volume. The second and third place sponsors are the Departments of Energy and Defense which each account for some 20 percent of the volume.

Institutes and centers focus much of the CSM research activities. The range of interests in this type of development span the campus and are closely identified with the needs of the minerals and energy industries. Titles of ongoing institutes include Earth Mechanics Institute, Center for Welding Research, BoM Generic Center for Comminution (Utah), Mined Land Reclamation Group (Colo. St. Univ.) and the Center for Potential Field Studies.

Georgia - Institute Profile
(1978-82)

Director John E. Husted
Georgia Mining and Mineral Resources Institute
Georgia Institute of Technology
Atlanta, Georgia 30332

Activities (average number per year):

Research projects	1
Faculty support	1
Student support	
Undergraduate	1
Graduate	1

Total value of equipment purchased: \$110,073

Industrial Impacts:

Structural Location and Role of Hydrogen Ions in Kaolinate and Its
Products in Aluminum Removal

A complete crystal structure refinement of a kaolinite has been achieved for the first time. Leaching studies of calcined kaolinite include first attempts at producing a zeolite as a by-product. Possible new industrial potential of 500 million dollars has been identified.

Other Beneficial Impacts:

The Mineral Institute program has had a definite positive impact both at Georgia Tech and within the state. The areas of impact are as follows:

1. Georgia Tech. The Mineral Institute has bolstered the mineral engineering program and encouraged the administration to proceed with an enlarged offering.
2. It has garnered industrial support and brought officers of the Georgia Mining Association and key mineral industry administrators within the State of Georgia together to back a minerals engineering program of research and education at Georgia Tech.
3. Industrial research is starting to come to the Institute.

Idaho - Institute Profile
(1978-82)

Director George A. Williams
College of Mines
University of Idaho
Moscow, Idaho 83843

Activities (average number per year):

Research projects	4
Faculty support	3
Student support	
Undergraduate	1
Graduate	5
Post-doctorals	0.2

Total value of equipment purchased: \$39,161

Industrial support for scholarships,
fellowships and assistantships: \$60,000/year

Industrial Impacts:

1. Fracture Control of Coeur d'Alene Ore Deposits, R.R. Reid and W. B. Hall

This research emphasizes the reconstruction of a structure model based upon detailed field mapping carried out both on the surface and underground. With the information, a palinspastic reconstruction of the structural geology of the mining district has been prepared. The model points toward regional-stratigraphic and structural control for the ore deposits. In addition, it is felt that the ores are localized within close proximity to the Lewis and Clark shear zone.

2. Legal Pitfalls, Land Status and the Acquisition of Mineral Rights, Olen P. Matthews

Increased mineral demands have made mineral development within the United States an important issue. This is at a time when the economic and legal variables that influence mineral development have been changing rapidly. The issue is extremely important on federal lands in the western states. Changing the laws that applies to these lands, changes the potential for development. Recent laws have been passed which have withdrawn land from development or have severely restricted the use of the land. There is a need for developers to understand how the laws related to status affect mining development. This monograph is a step toward determining the relationship between the legal system, and the acquisition of mineral rights. The monograph has been in demand from most legal companies and law colleges.

Other Beneficial Impacts:

The Idaho MMRII has been influential in supporting the needs of the mineral industry in the state. Metallurgical techniques developed through support of the institute is now in the production stage in several mills in the state. The support of a seminar in Geography related to the mineral industry brought in numerous experts to teach students and expand the offerings within the college.

Illinois - Institute Profile
(1978-82)

Director James Swisher
Coal Research Center
Southern Illinois University at Carbondale
Carbondale, Illinois 62901

Activities (average number per year):

Research projects	8	Student support	
Faculty support	7	Undergraduate	2
		Graduate	7
		Postdoctorals	0.6

Total value of equipment purchased: \$51,356

Industrial support for scholarships, fellowships and assistantships: \$9,000 per year

Industrial Impacts:

1. Coal Fines Recovery and Utilization

A process for recovery of energy from waste coal fines was developed through laboratory, bench, and pilot plant scale experiments. It consists of mechanical cleaning followed by high temperature oil agglomeration of pelletization. The process can produce a quality product under an economically and environmentally acceptable condition.

2. Productivity of Parent Materials on Mines Prime Farmlands

Still in process, the intent of this study is to evaluate reclamation methods using different parent materials for B horizon replacement and organic amendments for topsoil replacement at a reduced cost while still maintaining or improving the food-producing potential of the mined soil. Selected parent materials are being evaluated as rooting media for corn and soybeans. The results will aid in reducing reclamation costs, energy consumption, and the time required to properly reclaim mined prime farmland.

Other Beneficial Impacts:

One of IMMRRI's priorities has been the funding of reclamation research. Over the past four years, IMMRRI has awarded sixteen program development "starter" grants in the reclamation area. Arising from this emphasis on reclamation, IMMRRI, along with the Coal Research Center at SIUC, have been sponsors of the annual Midwest Reclamation Tour. For two days, sixty to a hundred individuals from industry, government, and academic institutions tour strip mined lands in Illinois, Indiana, Kentucky, and Iowa. Reclamation practices at mine sites in these areas are examined.

The reclamation emphasis also led to the Department of Energy's funding of the 1983 Coal Research Center's publication, The Surface Mining Environmental Monitoring and Reclamation Handbook. This Handbook furnishes coal mine operators with cost-effective techniques for compliance with monitoring requirements of the Surface Mining Control and Reclamation Act.

Largely through IMMRRI-funded preliminary studies, faculty members have received several contracts from coal companies for research on mining efficiency, mine safety, and subsidence prevention.

Indiana - State Profile
(1978-82)

Director Donald W. Levandowski
Geosciences Building
Purdue University
West Lafayette, Indiana 47907

Activities (average number per year):

Research projects	5	Student support	
Faculty support	5	Graduate	10
		Postdoctors	0.4

<u>Total value of equipment purchased:</u>	\$ 35,000 (Federal)
	\$400,000 (Non-Federal)

Industrial Impacts:

1. Dispersion Stability and Rheology of Bauxite Tailings

A major issue facing the mineral processing industry is the transportation and disposal, or further utilization of mineral tailings. Tailings from alumina production, known as "red muds," are produced at 10 million tons per year. Because these tailings are quite toxic, they must be isolated indefinitely. Moreover, red muds contain potentially usable materials, such as iron oxide, titanium oxide, sodium hydroxide, and additional alumina. An understanding of the flow characteristics of the tailings is required to develop economically feasible processing technologies for separating the useful materials and concentrating the remaining waste into a compact solid form.

2. Simulation-Optimization Model for Exploration and Exploitation of Exhaustible Mineral Resources

The objective of this research was to develop a computer model of the exploration and exploitation processes for mineral resources. The use of simulation models with imbedded optimization modules provides mineral industry firms with powerful mathematical techniques which can be used as evaluation tools.

3. Slope Stability Relative to Coal Mining in the Illinois Basin

Slope stability studies are underway for open pit coal mines where lake bed clays occur at the earth's surface. Failure in the cast over piles or in the cut face cause costly delays in the mining process. In another study, the instability of selected roof areas of an underground coal mine are being evaluated using geophysical logs obtained during coal exploration. Prediction of these roof fall areas may be possible on the basis of the logging data obtained during the exploration and development of the coal body.

Other Beneficial Impacts:

Cooperation with several mining companies nationally and in Indiana and Illinois has been achieved through these IMMRI supported research projects. The Department of Natural Resources of Indiana has also participated in projects with IMMRI. Practical problems of interest to mining companies or to the state agencies are selected which provide valuable training for students who work on real life problems.

Iowa - Institute Profile
(1978-82)

Director Ray W. Fisher
Iowa State University
Room 321 Spedding Hall
Ames, Iowa 50011

Activities (average number per year):

Research projects	12	Student support	
Faculty support	10	Graduate	12
		Undergraduate	1
<u>Total value of equipment purchased:</u>		\$68,000	

Industrial support for scholarships,
fellowships and assistantships: \$32,000 per year

Industrial Impacts:

1. Coal Preparation Research Facility at Iowa State University

Our facility evaluates and develops coal preparation processes to aid in preparation plant design, and to prepare specification coals for new application. Operation of the facility has resulted in the commercial design of a heavy-media vessel, of which 19 have already been sold (sales of approximately \$5,000,000). Two commercial coal preparation plants costing over \$3,000,000 each, have come into being in the State of Iowa as a result of this work, and several commercial processes have been modified. Researchers (students) have taken supervisory positions in the mineral industry.

2. Dewatering of coal and mineral sludge by pressurized electroosmosis

Electroosmosis can be successfully used to enhance the dewatering of coal sludge, coal suspensions, sewage sludges, mill tailings, slimes, pulps, and other materials which are difficult to dewater. This method is useful in the preparation of specialty fuels and minerals from waste materials. It is currently being tested for possible commercialization.

Other Beneficial Impacts:

Developed a patentable safety device to test rock strength and a method to measure in-situ stress in underground mine workings, an industrial process to recover iron ore from power plant fly ash, an electrowinning method to recover copper from aqueous solutions by means of a fluidized bed electrochemical reactor, and a method to determine the concentration changes during the dissolution of a uranium dioxide-pyrite mixture with application to leaching uranium ore from the ground; operated successfully a surface coal mine, processed over 100,000 tons of coal by conventional and experimental beneficiation methods, and restored the strip-mined land to a higher level of agricultural productivity; stimulated the formation of a new interdepartmental graduate minor in mineral resources and expanded the number of courses offered in such areas as mining methods, mineral processing, reclamation of mined land, industrial minerals, extractive metallurgy, and coal science and technology; attracted over \$125,000 for cooperative research under ISMMRRI direction and over \$900,000 additional funds into Iowa State University for research addressing mining and mineral-related activities.

Kentucky - Institute Profile
(1978-82)

Director Lyle V. A. Sendlein
Institute for Mining and Minerals Research
321 Patterson Office Tower
University of Kentucky
Lexington, KY 40506

Activities (average number per year):

Research projects	7	Student support	
Faculty support	10	Graduate	16
		Undergraduate	10 (Additional 60 per year from matching state money)

Total value of equipment purchased: \$92,891

Industrial support for scholarships,
fellowships and assistantships: \$45,000 per year

Industrial Impacts:

1. Hydrology and Sedimentology of Surface Mined Lands

A reasonable prediction of the effect of mining on an area's hydrology and sedimentology can now be made. The size of a sediment pond needed to be constructed to meet a given effluent standard can also be predicted.

2. Mining Engineering Continuing Education

The program provides continuing education for practicing engineers and related professionals serving the mining industry and assists them in implementing the Surface Mining Control and Reclamation Act. Since 1978 the Office for Informational Services and Technical Liaison at the IMMR and the Engineering Continuing Education Office have conducted more than 150 short courses, seminars, workshops and symposia with more than 5,000 attendees.

Other Beneficial Impacts:

Since the 1972-1973 academic year, the IMMR has received \$38,579,530 to conduct the Coal and Mineral Research and Development Program for the Commonwealth of Kentucky at the Kentucky Center for Energy Research Laboratory. The primary factor for the University being selected as the contractor to operate this government-owned, contractor-operated laboratory was the existence and activities of the IMMR, and the commitment exists on behalf of the Commonwealth that the IMMR will continue to operate the KCERL. The impact of becoming a Title III Institute has resulted in increased growth in the R&D program beginning in 1978 when the appropriations for the Laboratory program from the Commonwealth approximately doubled. Conducted 153 short courses, seminars, workshops and symposia (1978-82), treating topics such as "Stability Analysis," "Permitting Procedures," "Surface Blasting Certification," "Hydrology and Sedimentology of Surface Mined Lands," "Sediment Pond Design," "Kentucky Coal Refuse Disposal" and "Public Law 95-87, Surface Mining Control and Reclamation Act."

Louisiana - Institute Profile
(1978-82)

Director Ralph W. Pike
Mining and Mineral Resources Research Institute
Office of Research
Louisiana State University
118 David Boyd Hall
Baton Rouge, Louisiana 70803

Activities (average number per year):

Research projects	8
Faculty support	10
Student support	
Undergraduate	2
Graduate	4
Postdoctoral	0.4

Total value of equipment purchased: \$89,000

Industrial support for scholarships,
fellowships and assistantships: —\$60,000 per year

Impacts:

In minerals extraction research on diagenetic evolution of porosity in carbonates, isotopic analysis has shown very distinct patterns with regard to changing isotopic compositions in Pleistocene carbonates, and these results have been reported in research papers at meetings of the Geologic Society of America. In the study of enhanced recovery of oil using carbon dioxide, the equilibrium phase behavior has been correlated from laboratory experiments on the solubility of carbon dioxide in crude oil.

In the computer-graphics an interactive program is operational and is being used on mineral resources data bases to display statistical and geological data in a pictorial form. In minerals processing research a comparison of standard minerals processing computer-aided design programs has been completed for the two standard mineral industry processes with the results being presented to industry in publications and seminars. In optimizing the combustion characteristics of lignite and fuel oil the sonic burner configuration has been demonstrated to be superior to other designs, and work is proceeding to evaluate lignite - water mixtures in this burner.

In economic, legal and business research the cooperative project with the Mineral Law Institute has completed a thorough search of recent litigation associated with tax sales of property and the transfer of mineral rights with these sales. Recommendation for legislation have been made to clarify the confusion that now exists in these sales. In economic projections a definite impact on the petroleum industry in the Gulf coast of the initiation of production of petrochemical products in the Middle East in 1985 showed compensating factors replacing lost markets. Environmental impact studies of fly-ash from lignite show essentially no major contamination from leachates under acid rain conditions.

Massachusetts - Institute Profile
(1978-82)

Director John F. Elliott
Mining and Minerals Resources Research Institute
Room 4-140
Massachusetts Institute of Technology
77 Massachusetts Avenue
Cambridge, Massachusetts 02139

Activities (average number per year):

Faculty support	8
Student support	
Graduate	4

Total value of equipment purchased: \$77,357

Industrial support for scholarships,
fellowships and assistantships: \$279,000 per year

Industrial Impacts:

1. Remote Control Mining Programs

This study and research is directed to evolutionary change in mine design and mining operations for underground mining of coal. A long term objective is to remove personnel from the most dangerous area, the work face, and simultaneously increase the productivity of the operation. As the program progresses, spin-offs of innovative sensing methods and designs should be forthcoming.

2. Process Metallurgy Programs

A very active program of modelling turbulent conditions in the liquid phases in smelting and refining operations provides means of characterizing parameters relating to heat and mass transport in industrial scale operations.

Other Beneficial Impacts:

The MMRRRI Program and the Institutional Grant are being employed to encourage interest in mineral related teaching and research activities at MIT. Three research programs were established recently, the Remote Control Mining Program, the Underground Fracture Program and the REMERGENCE Laboratory (Resource Extraction, Materials and Energy, Reservoir, Geotechnical, Environmental, and Construction Engineering). These programs are now free standing, but have received support in various ways from MMRRRI funds. MMRRRI funds have also been instrumental in reestablishing the program in Mineral Engineering at MIT. Funds from the institutional grant are employed to support both faculty and graduate students with ideas for innovative research programs.

Michigan - Institute Profile
(1978-82)

Director Lloyd A. Heldt
Center for Mining and Mineral Resources Research
Michigan Technological University
Houghton, Michigan 49931

Activities (average number per year):

Research projects	11
Faculty support	4
Student support	
Undergraduate	4
Graduate	4

Total value of equipment purchased: \$62,000

Industrial support for scholarships, fellowships and assistantships: \$70,000

Industrial Impacts:

1. Micro Froth Flotation

Research on the use of micro froths for flotation of fine ores, including Michigan iron ores, has attracted significant industrial interest and support. Bench scale tests and computer modeling of the process evidence high efficiencies.

2. Economics of Underground Vs. Surface Mining

The impacts of increased energy costs were analyzed. Industrial interest has resulted in wide distribution of this report.

Other Beneficial Impacts:

1. Elastic Stress Wave Propagation in Underground Mining

This research has provided valuable new information which is employed in analyzing the deterioration of mine structures caused by repeated explosive blasting.

2. Development of Control Systems for Coal Processing

Sensors and computer software were developed to monitor ash content of coal on-stream in coal processing plants. The project has progressed to pilot scale and industrial demonstrations with success. Significant increases in coal processing efficiency should result.

3. Development of Guidelines for Closing Underground Mines

Deficiencies in mine closures were documented. Subsidence, shaft failures, acid or toxic water damage are included. Remedial measures are recommended following field studies in coal producing and metal productive areas. *ing*

Minnesota - Institute Profile
(1978-82)

Director Kenneth J. Reid
Mineral Resources Research Center
University of Minnesota
56 East River Road
Minneapolis, Minnesota 55455

Activities (average number per year):

Research projects	4
Faculty support	4
Student support	
Graduates	7
Undergraduate	2
Postdoctoral	2

Total value of equipment purchased: \$77,357

Industrial support for scholarships,
fellowships and assistantships: \$56,000 per year

Industrial Impacts:

1. Chemistry and Mineralogy of Cementitious Materials

Novel cements can be made in a plasma reactor. This opens up the possibility of a range of nonconventional materials tailored to particular objectives. The economic impact of this work could be very large in the basic cement/concrete industry.

2. By-product Recovery from Copper-Nickel Bearing Duluth Gabbro

A low-grade copper-nickel deposit (averaging 0.6% copper and 0.2% nickel) estimated at 4.6 billion tons, occurs in northeastern Minnesota. This project provides basic information on process economy and resource conservation through by-product recovery and on environmental protection through removal of potentially hazardous components in the tailings.

Other Beneficial Impacts:

The dedicated Computer Interactive Graphics Facility for Undergraduate Syntheses and Systems Analysis Laboratory is being used to introduce design and systems concepts to undergraduate mining engineers. Special purpose computer software was developed for a PDP 11/60 mini-computer with Tektronix terminals and the use of this software was integrated into undergraduate courses. Software packages included linear programming, critical path scheduling and a truck-shovel simulator.

A major result of the establishment of the laboratory has been a complete reorganization, over two years, of a senior course in mine systems analysis. The entire course is now built around the computer laboratory.

The laboratory facilities have been used to encourage development of software suitable for undergraduates. One development is aimed at replacing lectures in geostatistics by a series of exercises on the computer.

Mississippi - Institute Profile
(1978-82)

Director J. Robert Woolsey
University of Mississippi
Mineral Resources Institute
University, Mississippi 38677

Activities (average number per year):

Research projects	22
Faculty support	4
Student support	
Undergraduate	3
Graduate	14

Industrial Impacts:

Wilcox Lignite Study

3.3 billion tons of lignite within 300 feet of the surface were delineated in Lauderdale County, Mississippi.

Other Beneficial Impacts:

Offshore Heavy Mineral Program: Provided support for a sub-bottom profiling and grab sampling survey of offshore Mississippi waters, which determined the occurrence of considerable surficial concentrations of high grade TiO_2 and ZrO_2 minerals, as well as significant amounts of high grade refractor minerals.

Zeolite Project: Provided funding for a preliminary field and drill sampling investigation of considerable quantities of clinoptilolite in southeast Mississippi.

Developed information dissemination system through a newsletter; sponsored lignite seminar.

Missouri - Institute Profile

Director David J. Barr
 School of Mines and Metallurgy
 University of Missouri-Rolla
 112 Mining Building
 Rolla, Missouri 65401

Activities (average number per year):

Research projects	7
Faculty support	7
Student support	
Undergraduate	4
Graduate	17

Total value of equipment purchased: \$127,000

Industrial support for scholarships, fellowships and assistantships: \$173,000 per year

Industrial Impacts:

1. Digital Data Base for Coal Mine Subsidence

This research project demonstrated the usefulness of merging engineering and geological data by means of digital image and map processing. Coal mine subsidence was correctly predicted within the study area and correlated with surface land use.

2. Studies of Atmospheric Fogging in Underground Mine Airways

University and Industry personnel worked cooperatively to seek solutions to fogging problems in a mine in the Missouri Lead Belt.

3. Effect of Pelletization on the Sintering of a Lead Charge

This cooperative research with industry led to a Ph.D. dissertation containing recommendations for attaining increased lead processing and smelting efficiency.

Other Beneficial Impacts:

The Missouri Mining and Mineral Resources Research Institute has stimulated activity within all disciplines of the School. Recent technology transfer activities include symposia on Rock Mechanics, Water Jet Technology, Remote Sensing and Digital Data Bases, Ore Microscopy, Electro-metallurgy, Mississippi Valley Type Lead-Zinc Deposits and Characterization of Missouri Coal.

The MMRI program has supported the initiation of research for 7 Ph.D. candidates during this past year. In each instance the nominal financial assistance has allowed the students to organize their respective research objectives, initiate the research and seek additional funding from external sources when necessary. Also, several laboratories have been upgraded and support has been provided for newer faculty.

A major effort has been undertaken to procure microcomputers for use in classroom instruction and research. Microcomputer applications are now being integrated into most courses with a considerable benefit to our students.

Montana - Institute Profile
(1978-82)

Director Edward C. Bingler
Montana College of Mineral Science & Technology
Butte, Montana 58701

Activities (average number per year):

Research projects	1
Faculty support	1
Student support	
Undergraduate	1

Total value of equipment purchased: \$128,917

Industrial support for scholarships,
fellowships and assistantships: \$240,000 per year

Industrial Impacts:

1. Projection of Coal Demand from the Northern Great Plains through the year 2010

This study was based on an economic model of the spatial markets and updates an earlier study. The Powder River Basin represents the largest pool of underdeveloped leased Federal coal land in the United States and presently accounts for about half of all Federal coal production. The scale and timing of production is clearly tied to Federal reclamation and leasing policy. The model indicates that future production will be tied to demand for electricity in the market area.

The report has been requested and studied by persons in government and industry since the economy of the region will be vitally affected by future coal development.

2. Vibrated High-Modulus Fills in Underground Mines

Procedures were developed for emplacing and testing fills of mine and mill tailings. Application of the results in underground mines in the Coeur D'Alene district has been subject of further work, interrupted by strikes. The technological/economic impact is evaluated as favorable and there is a favorable safety impact.

Other Beneficial Impacts:

One benefit that must be mentioned is that mineral institute funding enabled the establishment of technical support areas for electronics and machine shop facilities. These were not previously available on campus. Both facilities are now operating and are now close to self-supporting so that all mineral institute financial support can be withdrawn within about a year. Presently about 25% support is provided. The establishment of these service support areas has definitely strengthened our research capabilities as well as our instructional program. Short courses on Ventilation (1979 and 1981) and publication on Mineral Processing.

Nevada - Institute Profile
(1978-82)

Director James L. Hendrix
Mackay School of Mines
University of Nevada at Reno
Reno, Nevada 89557

Activities (average number per year):

Research projects	5
Faculty support	3
Student support	
Undergraduate	20
Graduate	11

Total value of equipment purchased: \$55,000

Industrial support for scholarships,
fellowships and assistantships: \$60,000 per year

Industrial Impacts:

1. Recovery of Copper, Arsenic, Bismuth & Antimony from Copper Smelter Slag Wastes

Copper slag was reduced with carbon to yield metals listed above. The research results served to increase metals recovery from industrial wastes.

2. Studies Concerning the Metallurgy of Gold

Multiple studies associated with the hydrometallurgy of gold. Studies evaluating hydrometallurgical methods for recovery of gold from ores have been conducted. Also, studies concerning the fundamental chemistry of gold within carbonaceous ore bodies, as well as evaluation of carbons for the use in the carbon-in-pulp circuits have been studies.

Other Beneficial Impacts:

Other beneficial impacts of the MMRI program include: Leverage with industrial concerns for fund raising activities; enhancement of campus, state and industry perception of Mackay School of Mines; travel opportunities for faculty and students to professional meetings; enhanced recruiting opportunities.

Of special note is the flexibility in research that our long time established School of Mines has gained by the use of research assistantships and fellowships funded by MMRI monies. New Ideas can be pursued, as well as new faculty assisted in establishing their research program, by the availability of MMRI fellows.

New Mexico - Institute Profile
(1978-82)

Director Arpad E. Torma
New Mexico Institute of Mining and Technology
Campus Station
Socorro, New Mexico 87801

Activities (average number per year):

Research projects	11
Student support	
Undergraduate	8
Graduate	5

Total value of equipment purchased: \$84,702

Industrial support for scholarships,
fellowships and assistantships: \$115,000 per year

Industrial Impacts:

1. Radionuclides and Heavy Metal Distribution

Project aim was to determine extent to which uranium mining activity in the Grants Mineral Belt of New Mexico contributed excess trace minerals to sediments in that area during the last 30 years. Various dating methods including gamma ray spectrometry are used. The cost to clean up uranium processing spills is immense since it is difficult to distinguish between debris from the spill and naturally occurring material. Application of this technique could reduce cleanup costs significantly.

2. Gases in Hydrous Minerals

An exploration tool for ore deposits, the project determined gas content of hydrous minerals could be used as an exploration indicator for ore deposits. A firm has been organized to perform this kind of analysis.

Other Beneficial Impacts:

The Mineral Institute at New Mexico Institute of Mining and Technology (NMIMT) is organized to assume an important role in the mineral-oriented research and educational training and to strengthen the mission of NMIMT. In many instances, the Mineral Institute provided money to hire new faculty with distinguished records of research. These experts in addition to their educational contribution, help solve problems of concern to New Mexico's petroleum, mining and metallurgical industries. Undergraduate scholarships, graduate and postdoctoral fellowships were awarded to outstanding candidates, who, on the basis of these awards, often made their career choice to stay with the mineral industries. Further research activities were initiated by providing "seed" money for trying out new promising ideas which could lead to the development of an important project, as capital equipment was purchased which improved the NMIMT research capabilities. The members of the Mineral Institute have participated in workshops, congresses and short courses of national and international importance.

North Dakota - Institute Profile
(1978-82)

Director Gerald H. Groenewold
Mining and Mineral Resources Research Institute
Box 8103 University Station
Grand Forks, North Dakota 58202

Activities (average annual number per year):

Research projects	7	Student support	
Faculty support	3	Undergraduate	8
		Graduate	5
		Postdoctorals	0.2

Total value of equipment purchased: \$114,000

Industrial support for scholarships,
fellowships and assistantships: \$27,000 per year

Industrial Impacts:

1. Mineral Resources and Potential Problems Associated with Mining of Cenozoic Rocks of the Williston and Powder River Basins, Northern Great Plains

This study represents the first detailed regional evaluation of the coal-bearing strata of the Ft. Union Region. As such it provides the basis and necessary data for designing exploration programs, predicting mining design problems and predicting the impacts of mining on the environment.

2. Cooperative Program to Evaluate Surface and Groundwater Problems Associated with Stripmine Sites

Two modeling efforts have been completed. The groundwater response model predicts mining impacts on ground water and, in turn, has been used as an aid in the design of mining operations. The hydro-geochemical model is capable of predicting the hydrochemical impacts of surface mining in various settings.

Other Beneficial Impacts:

The improved relationship, since the MMRI was funded, between the industrial and academic communities in North Dakota has been striking. There has been a growing commitment to support and cooperate on various research topics. The mining and energy resource companies have become actively involved in the design of our academic programs and have provided industry personnel for teaching. The mining engineering curriculum has been significantly expanded and a new faculty position in mining engineering has been filled utilizing MMRI funds. The MMRI program has resulted in a significant increase in student enrollment in the mining engineering curriculum and has influenced both faculty and students to pursue research related to mining and mineral resources. The North Dakota mining industry agreed to annual support 18 undergraduate summer workstudy positions. MMRI funds have been utilized to provide equipment and personnel for the Natural Materials Analytical Laboratory (NMAL). The NMAL is a modern analytical laboratory that is designed to promote mineral-related research and education. NMAL equipment includes a scanning electron microscope and microprobe, x-ray diffraction and x-ray fluorescence. Completion of the NMAL places the North Dakota MMRI in a highly competitive position to pursue mineral and energy resource-related projects and greatly facilitates the training of students in mineral and mining programs. During the two year period, 1980-1982, three short courses and two seminars were conducted.

Ohio - Institute Profile
(1978-82)

Director Calvin J. Konya
Ohio State University
233 Koffolt Labs
140 W. 19th Ave.
Columbus, Ohio 43210

Activities (average number per year):

Research projects	18
Faculty support	13
Student support	
Undergraduate	2
Graduate	5
Postdoctoral	1

Total value of equipment purchased: \$108,649

Industrial support for scholarships,
fellowships and assistantships: \$60,000 per year

Industrial Impacts:

1. Bacterial Desulfurization of Coal

A unique process of sulfur removal has been developed at the Ohio Institute. This process will remove up to 95% of pyritic sulfur and as much as 70% of the total organic and pyritic sulfur and sulfate from Ohio coals. The process functions at a rate four times faster than any previously reported.

2. Control of Airblast and Excessive Ground Vibration by Use of Efficient Stemming

The object of this research was to determine how stemming functions in a borehole and the parameters which could be used to reduce unwanted effects from the blasting. The study was the first ever to directly measure borehole pressure. The study defined methods by which airblast and ground vibration from blasting could be minimized.

Other Beneficial Impacts

The Ohio Institute played a vital role in focusing attention on minerals research at The Ohio State University and at other universities within the State. The program has encouraged minerals research by offering minerals fellowship assistantships and "seed money" for new and innovative research through an initiation grants program. The State has responded by including a line item of \$400,000 per year to be used in coal research. As a result of the Institute program, research activities in the minerals area has dramatically increased over that which existed before 1978. Many new minerals faculty have been hired, and a graduate program in mining engineering has been established.

Oklahoma - Institute Profile
(1978-82)

Director Robert H. Arndt
University of Oklahoma
830 Van Vleet Oval - Room 163
Norman, Oklahoma 73019

Activities (average number per year):

Research projects	6
Faculty support	5
Student support	
Undergraduate	2
Graduate	7
Postdoctoral	0.2

Total value of equipment purchased: \$97,800

Industrial Impacts:

In Situ Mining of Bituminous Coal

A method was developed which is now being applied in an attempt to convert Oklahoma Waste Coal to Asphalt. The conversion project is sponsored by the state of Oklahoma.

Other Beneficial Impacts:

In the past two years exposure to OMMRRI and assistance supplied by OMMRRI has nurtured interest in rock mechanics for two professors in Aerospace, Mechanical and Nuclear Engineering. The immediate thrust is toward problems in oil recovery. This new interest has attracted at least 3 graduate students. AMNE considers this to be a strong upgrading of departmental offerings. Support has been given to a new professor in the School of Chemical Engineering during the last two years to assist in the establishment of engineering research in the field of enhanced recovery of oil. The new programs in AMNE and CEES complement a well established basic research program in enhanced recovery of oil in the Department of Chemistry. The latter program addresses the relationships between surfactant, fluid and mineral grains, and the solubilization of hydrocarbons. Mutual interests among the investigators have led to fruitful discussions and informal linkage of efforts between the College of Arts and Sciences and the College of Engineering.

A core-drilling campaign to evaluate resources of heavy oil and tar sands in the Arbuckle Mountains of south-central Oklahoma has been pursued by the Oklahoma Geological Survey for more than a year. OMMRRI provided a respectable increment of the purchase cost of the drilling rig used by the Survey. Sponsored 3-week energy field course (1979); \$26,500 used to purchase technical literature, collect Oklahoma mineral industry news and items needed by Petroleum and Geological Engineering departmental libraries (1979-83).

Pennsylvania - Institute Profile
(1978-82)

Director Z. T. Bieniawski
Pennsylvania State University
110 Mineral Sciences Building
University Park, Pennsylvania 16802

Activities (average number per year):

Research projects	7
Faculty support	8
Student support	
Undergraduate	3
Graduate	12

Total value of equipment purchased: \$78,904

Industrial support for scholarships,
fellowships and assistantships: \$81,200 per year

Industrial Impacts:

1. Factors Controlling the Generation of Acid Mine Drainage

Based on laboratory tests and field work in western Pennsylvania, relations between acid drainage, pyrite in coal, pyrite in overburden, and carbonate minerals in overburden show that acid production is dependent on pyrite content of the overburden rather than pyrite in the coal. The work forms the basis of several large research and demonstration projects for testing and extending the ideas of carbonate control of acid.

2. Size Reduction and Liberation

Studies have resulted in a major technological process innovation that involves a combination of the calcination and sintering phenomena into a single step process. Technologically, this new process has major implications for the processing of many other ceramics, as well as for the processing of basic refractories. It provides a production adaptable process that is both cost and time effective.

Other Beneficial Impacts:

The Mineral Institute has stimulated the preparation of a comprehensive research proposal to the Standard Oil Company of Ohio (Sohio). This proposal was successful and a Sohio Center for Scientific Excellence in Mining Technology was established at Penn Station with a funding of \$2 million over the five year period (1983-88). Improved health, safety and productivity in the longwall method of underground coal mining are the goals of this research.

The MRI funding resulted in bringing in a senior faculty in mineral processing and supporting a broad range of outstanding graduate students in the areas of mining, mineral processing, geomechanics, fuel science, petroleum engineering, metallurgy, ceramic science, mineral economics and geosciences. During 1982, the MRI provided \$20,250 in research initiation which attracted no less than \$345,000 from industry in the area of mineral processing.

South Dakota - Institute Profile
(1978-82)

Director R. Norman Orava
School of Mines and Technology
500 East St. Joseph Street
Rapid City, South Dakota 57701

Activities (average number per year):

Research projects	10
Faculty support	8
Student support	
Undergraduate	2
Graduate	5

Total value of equipment purchased: \$119,146

Industrial support for scholarships, fellowships and assistantships: \$66,000 per year

Industrial Impacts:

1. Study of Temperature Profiles in Rock Using a Thermistor Probe

Equipment has been developed to measure the heat transfer properties of different rock types. A probe has been designed, constructed and tested to provide temperature readings inside diamond drill holes underground. Results are being used to improve underground ventilation systems.

2. Oxidation of Pyrite to Maghemite

A thin film of rust forms on the surface of pyrite under oxidizing conditions. This rust (maghemite) is only 70-100 microns thick but increases the magnetism of these small grains by an order of magnitude. This holds promise of allowing inexpensive removal of pyrite from coal, especially in slurry.

Other Beneficial Impacts:

The South Dakota MMRI played an indispensable role in providing the resources to persuade Dr. James J. Papike, an outstanding geologist and alumnus, to return to the State and join our faculty. With his leadership, the Institute for the Study of Mineral Deposits was established in 1981. The Institute has about one-quarter million dollars of research support from NASA, NSF, and DOE. His presence also resulted in the loan by NASA Johnson Space Center of a \$300,000 electron microprobe, a facility unique to the state. Dr. Papike's projects have also contributed to the acquisition of an atomic absorption/inductively-coupled plasma spectrometer. Both instruments upgrade the School's capabilities with direct benefits to the solution of the nation's problems. Conducted or assisted in conducting various workshops, conferences and short courses: (1) "What Mining is All About," "Computer Applications for the Mineral Industry," "Western Regional Conference on Gold, Silver, Uranium and Coal," "Remote Sensing," "Oil and Gas Potential in South Dakota," (1981); (2) "Remote Sensing," "Coal Bearing Sequences," "Spontaneous Combustion of Coal," "Oil and Gas Potential in South Dakota," "Status at Coal Geology in Northern Great Plains" (1982). Supported new faculty member in mining (1982).

Texas - Institute Profile
(1978-82)

Director L. F. Brown, Jr.
Bureau of Economic Geology
University of Texas - Austin
University Station Box X
Austin, Texas 78712

Activities (average number per year):

Research projects	6
Faculty support	4
Student support	
Undergraduate	2
Graduate	9

Total value of equipment purchased: \$56,484

Industrial support for scholarships,
fellowships and assistantships: \$10,238 per year

Industrial Impact:

1. Assessment of Lignite Exploitability in the Deep Basins of Texas

Research funded by the Mineral Institute led to development of generic concepts to fully exploit Gulf Coast lignite resources. Depositional systems analysis permits prediction of distribution, approximate reserves, quality, and environmental impact before mining. Further research developed techniques and models required to assess engineering and economic feasibility for in situ extraction. Hydrochemical models of fluid flow in lignite strata provide the basis for evaluating the environmental, engineering, and economic future of Gulf Coast deep-basin lignite resources. Research continues in all phases including petrographic and geochemical characterization of lignite to permit proper utilization of the resource.

2. Mineral Exploration Models in Trans-Pecos Texas

The Mineral Institute and Texas have supported development of frontier exploration concepts in Southwest Texas, a province with enormous potential but limited exploitation of hard minerals. Using modern structural and igneous geological approaches, considerable advancement of mineral potential has been accomplished. Exploration models developed from geological and geochemical data collected in this project will continue to encourage and assist exploration by the mining industry. This region may be a critical new minerals province in the 21st century.

Other Beneficial Impacts:

Mineral Institute funds stimulated appropriation of \$158,000 in State funds to permit establishment of the first State Coal Laboratory and complete modernization of the University's Mineral Studies Laboratory. An international quality lab in the State is and will continue to stimulate further State funding and cooperation with Texas industry interested in the potential for mining, minerals extraction, and utilization. This capability, coupled with proven expertise in in situ extraction research for uranium and lignite, provides the basis for growing industrial and university cooperation for decades to come.

Utah - Institute Profile
(1978-82)

Director Ferron A. Olson
University of Utah
412 Browning Building
Salt Lake City, Utah 84112

Activities (average number per year):

Research projects	15
Faculty support	1
Student support	
Undergraduate	13
Graduate	20

Total value of equipment purchased: \$365,000

Industrial support for scholarships,
fellowships and assistantships: \$42,000 per year

Industrial Impacts:

1) Design and construction of a Laser Monitoring System to detect ground settlement. The system was designed to monitor vertical settlement of mine waste embankments. Such monitoring is desirable to detect anomalous movement which might indicate potential instability. The system is now operational and has successfully detected movement with minimum interference to mining operations.

2) Development of an air sparged hydrocyclone which will allow separation of minerals in a much smaller space than has been heretofore possible in the usual flotation cells. This novel device has promise in mineral separation and has received considerable interest.

Other Beneficial Impacts:

The Utah MMRI has significantly helped maintain a strong minerals program at Utah at a critical time when other funding was not available. Of the average number of 20 graduate students assisted each year since 1978 with support for research and stipends 16 have received M.S. degrees and probably more importantly 12 have received Ph.D degrees. Another 3 to 5 in each category will receive advanced degrees by July 1984. In addition to the direct support given to research one partial academic salary and some summer research support was given to new faculty. Funding has also been provided for an outstanding lawyer to teach a course each year in Mining Law.

Possibly the most significant recent impact has been the dramatic growth in comminution as a result of Utah obtaining federal funding, fall 1982, for the Generic Center in Mining Technology in Comminution. Specialized laboratories have been established in: Fragmentation, Automatic Control, Size Separation, Corrosion and Wear, Characterization and Computation. Visiting faculty, research professors, post doctoral students, technician and staff for a Reference Center in Comminution have been added to give the program a significant forward thrust towards establishing Utah as the outstanding academic center in comminution. Equipment has also been added to augment the previously established comminution facility. Industry has been supportive; \$205,000 of the annual budget is from industry.

Virginia - Institute Profile
(1978-82)

Director Paul E. Torgerson
College of Engineering
Virginia Polytechnic & State University
Blacksburg, Virginia 24061

Activities (average number per year):

Research projects	7
Faculty support	6
Student support	
Undergraduate	6
Graduate	5

Total value of equipment purchased: \$187,000

Industrial support for scholarships,
fellowships and assistantships: \$50,000 per year

Industrial Impacts:

1. Ground Control Mechanisms in Multi-Seam Mining

The objective is to develop quantitative techniques to determine the effects of stress in mining vertical multiple coal seams. A handbook will deal with multiple seams by advancing design procedures and solutions to problems which should reduce losses in the form of coal reserves no longer capable of being mined.

2. Image Processing for the Beneficiation of Complex Sulfide Ores

The objective is to use computer-analyzed television-derived images to determine the mineral relationships in ores and the rates of liberation in comminuted specimens. This will allow for more efficient processing and recovery of metal-bearing phases from complex sulfide ores.

Other Beneficial Impacts:

The Mineral Institute has stimulated the founding of Virginia Center for Coal and Energy Research by act of the legislature with the Governor's endorsement. This reflects the awareness in the state of the economic impact of the coal-producing industry, the coal-hauling railroads, the coal-burning electric utilities and the coal-exporting facilities at Hampton Roads, Virginia.

Money from the MMRRI program has influenced faculty to find ways to apply their expertise to problems of concern in the areas of minerals and mining.

Graduate assistantships have influenced students to choose their topics in minerals and mining, and influenced career choices. A former doctoral student whose research was on the analysis of synthetic fuels is currently in a postdoctoral position at Colorado State. His work is important for studies of catalysts.

Washington - Institute Profile
(1978-82)

Director O. J. Whittemore
Dept. of Materials Science and Engineering
University of Washington
Seattle, Washington 98195

Activities (average number per year):

Research projects	8
Faculty support	8
Student support	
Undergraduate	10
Graduate	33

Total value of equipment purchased: \$85,900

Mini-Research Projects:

The most successful activity of the Institute is the mini-research project. Seed money grants from \$2,500 to \$6,500 are made to faculty for the preparation of a research proposal to be submitted to another agency. Since the Institute began in 1980, 34 projects have been funded, from which proposals totalling over \$2,000,000 have ensued. Grants over \$400,000 have been identified as resulting from these proposals.

Successful projects have resulted in research on new processes for aluminum and iron reduction, on arsenic removal from copper ores, on development of olivine heat storage media, and on mine waste water detoxification. Current projects are on steel refining, arsenic in copper slags, refractory concrete, exploration geology, underground coal gasification, and mine wastewater treatment.

The projects are classified as: Extractive Metallurgy - 12; Exploration Geology - 9; Ceramics & Mineral Processing - 5; Environmental Aspects - 5; Mineral Economics - 1; Social Aspects of Mining - 1.

Appropriately the lead category is extractive metallurgy since in Washington the value of primary metals is many times that of mined minerals. Washington ranked first in primary aluminum production in 1982 and has the only copper smelter in the United States handling high arsenic ores and producing arsenic. The Washington manufacturing gross income of primary metals was \$2,303,700,000 in 1982 and for stone, clay, and glass: \$595,800,000. The value of Washington's nonfuel-mineral production was estimated in 1982 as \$183,000,000, of which nonmetal minerals accounted for 96% including cement, clays, diatomite, gypsum, lime, olivine and talc. Metal minerals totalled 4% and included silver, copper, gold, lead, and tungsten.

West Virginia - Institute Profile
(1978-82)

Director M. Dayne Aldridge
Energy Research Center
West Virginia University
258 Stewart Street
Morgantown, West Virginia 26506

Activities (average number per year):

Research projects	14
Faculty support	5
Student support	
Undergraduate	5
Graduate	14

Total value of equipment purchased: \$56,028

Industrial support for scholarships, fellowships and assistantships: \$232,000 per year.

Industrial Impacts:

1. Acid-Base Accounting

An "acid-base accounting system" has been developed and accepted as a standard by the West Virginia Department of Natural Resources, West Virginia coal operators and the U.S. Office of Surface Mining. Acid-base accounting determines the maximum amount of acid that a material is capable of producing and the corresponding amount of base necessary to totally neutralize the acid. The system, developed by Richard Smith and John C. Sencindiver, WVU division of plant and soil science, helps the surface mine operators to economically meet the requirements of current surface mining environmental laws. Technological Impacts: made surface mining at many West Virginia sights possible under Federal regulations.

2. Sediment Control Pond Baffles

Low-cost modifications to surface mine sediment control ponds have been tested and shown to be effective in decreasing the sediment load of effluent. The easily installed baffles were designed by Charles Jenkins, WVU professor of civil engineering. They increased sediment pond efficiency and decreased operating costs by allowing surface mine operators to construct smaller and longer-lasting ponds. The project was supported by funds from the WVU Mining and Minerals Resources Research Institute and by matching dollars from the state. Significant industrial involvement has helped in proving this development. Technological Impact: the cost of constructing and maintaining sediment control ponds is being significantly reduced.

Wyoming - Institute Profile
(1978-82)

Director David O. Cooney
P.O. Box 3295
University of Wyoming
University Station
Laramie, Wyoming 82071

Activities (average number per year):

Research projects	14
Faculty support	9
Student support	
Undergraduate	3
Graduate	13

Total value of equipment purchased: \$97,200

Industrial support for scholarships, fellowships and assistantships: \$25,000 per year

Industrial Impacts:

1. Influence of Powdered Activated Carbon Addition on Activated Sludge Oxygen Uptake Rates

Activated sludge treatment systems, widely used as a means of treating and disposing of organic wastes and proposed as a potential method for removing undesirable organic compounds from oil shale retort wastes are sometimes rendered ineffective because of poisoning from heavy metal ions or from organics, such as phenols. In this work, the effect of PAC was studied quantitatively in restoring biological activity of poisoned activated sludge.

2. Low Temperature Carbonization of Wyodak Coal

Low temperature carbonization of Powder River Basin coal can increase its heating value by as much as 40 to 60% through reduction of the moisture content. In addition, valuable gaseous and liquid products can be produced in the process. This project is designed to determine the important parameters in carbonizing prior to shipping by rail.

Other Beneficial Impacts:

Supported travel for faculty and students (1979); initiated Surface Mining Program (1980); hired two new faculty (chemical and petroleum engineering) (1981).



National Association
of State Universities
and Land-Grant Colleges

APPENDIX I

DIRECTORS OF

STATE MINING AND MINERAL RESOURCES AND RESEARCH INSTITUTES

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National Association
of State Universities
and Land-Grant Colleges

APPENDIX II

Robert L. Cochius, President

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Note: Dr. Barton was Chairman of the Committee in 1983 during the conception and assembly of this report.

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MINING
CONGRESS**

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J. ALLEN OVERTON JR.
PRESIDENT

APPENDIX III

AMC MINING AND MINERALS EDUCATION COMMITTEE

September 1983

Chairman: Jack E. Thompson, President, Newmont Mining Corporation, 200 Park Avenue, New York, New York 10166

J. R. Cool, Senior Vice President-Human Resources, Government and Public Affairs, Kennecott, P. O. Box 11248, Salt Lake City, Utah 84147

Alternate: Hugh W. Evans, President, Old Ben Coal Company, 69 W. Washington Street, Chicago, Illinois 60602

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Carl R. Heinz, President, Joy Machinery Company, 301 Grant Street, Pittsburgh, Pennsylvania 15219

Ralph L. Hennebach, Chairman, ASARCO Incorporated, 120 Broadway, New York, New York 10271

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Dean W. Lynch, Director of Public Relations, Duval Corporation, 4715 E. Fort Lowell Road, Tucson, Arizona 85712

Archie E. Moran, General Manager-Coal Operations, United States Steel Corporation, 600 Grant Street, Pittsburgh, Pennsylvania 15230

Mining and Minerals
Education Committee

-4-

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Richard F. Novak, Manager-Industrial Relations, The Cleveland-Cliffs Iron Company, 14th Floor Huntington Building, Cleveland, Ohio 44115

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N. R. Zehr, Vice President, Ingersoll-Rand Company, 200 Chestnut Ridge Road, Woodcliff Lake, New Jersey 07675

Appendix IV

Names of companies providing direct and indirect support of institute activities:

Air Products Corp.	Beaver Land Co.
AISI	Bechtel, Inc.
Alabama By-Products, Inc.	Beldon and Blake, Inc.
Alabama Methane Production Co.	Bethlehem Steel Corp.
Alabama Power Co.	Black & Vetch Consulting Engineers
Alaska Gold Co.	Black Diamond Coal Mining Co.
Alaska Mining	Black Hawk
Alcoa	Bluebird Operation
Alcoa Foundation	Breckinridge Minerals
Allegheny Land and Mineral	British Petroleum Ltd.
Allied Chemical Co.	C.E. Lummus
Alpine Resources	Caaterskill Exploration
AMAX	Callahan Mining Corp.
AMAX Arizona, Inc.	Cannelton Industries
Amax Foundation	Carbogel
Amax Zinc	Carter Mining Co. (Exxon)
American Association of Cost Engineers	CELCO Mining Co.
American Cast Iron Co.	CEM, Inc.
American Colloid Co.	Central Ohio Coal Co.
American Smelting and Refining Co.	Central Petroleum
American Society of Metals	Champlin
American Syncrude	Chemetico
Amoco	Chevron
AMOCO Foundation	Chevron Oil Field Research
Amoco Oil Co.	Christopher Foundation
Amoco Production Research	Cities Service Co.
Anaconda Co.	Cities Service Co.-Miami Copper Operations
Anaconda Copper Co.	Cities Service Coal Co.
Anaconda Grants, N.M. Uranium Leaching Plant and Tailings Disposal	Cities Service Oil Co.
Anaconda Minerals Co.	Cleveland Cliffs Iron Co.
Anamax Mining Co.	Coal Conversion Systems, Inc.
Anshutz Mining Co.	Coastal States
Arco Coal Co.	Cobb Coal Co.
Armco Foundation	Coca Cola
Armco Steel Corp.	Coggins Mine
ASARCO	Columbia Gas Research
Ashland Oil Foundation	Columbia Gas Transmission
Ashland Synthetic Fuels, Inc.	Cominco (U.S.) Ltd.
Associated Electric Co.	CONOCO
Atlantic Richfield	Consolidated Coal Co.
Atlantic Richfield Foundation	Consolidated Gas Co.
B.F. Goodrich Co.	Consolidation Coal Corp.
Bankhead Mining Co.	Continental Mines
Barnes and Tucker Coal Co.	Continental Pipeline Co.
Battelle Columbus Division	Cordero Mining Co. (Sun Oil)
Baukol-Noonan Inc.	Cotton Patch Mine
Beaver Creek Coal Co.	Cuber Co.
	Cyprus Bagdad Copper Co.
	Cyprus Johnson Copper Co.
	Cyprus Pima Mining Co.

Davey McKee Corp.
 Davison Mineral Properties
 Decker Coal Co.
 Diamond Shamrock
 Dixie Steel Corp.
 Dow Chemical Co.
 Dowell/Dow Chemicals
 Dravo
 Drummond Coal Co.
 Duval Corp.
 E.I. du Pont de Nemours and Co., Inc.
 Eagle Iron Works
 Eastern Associated Foundation
 Eastman Kodak
 Electric Power Research Institute
 Empire Coke Co.
 Energy Development Corp.
 Energy Enterprises
 ENKABV - Industrial Colloids - Holland
 Ensign-Bickford
 Envirotech Coal Services
 Ernest Leitz Wetzlar GmbH
 EXXON
 Exxon Educational Foundation
 Exxon Production Research
 Exxon USA Foundation
 Federal Bentonite
 FMC Corp.
 Ford Motor Co.
 Freeman United Coal Co.
 Gas Compression Roundtable
 Gas Research Institute
 Getty
 Goldfields
 Great Northern Iron Ore Properties
 Gulf Chemical and Metallurgical
 Gulf Oil Foundation
 Gulf Oil, Inc.
 Gulf Research and Development Corp.
 Gulf States Paper Co.
 Hach Chemical Co.
 Halliburton Gas Transmission
 Halliburton Services
 Hanna Mining Co.
 Hanson Oil Corp.
 Harbison-Walker Refractories
 Hastings Mining Corp.
 Hemscheidt America
 Hercules Aerospace
 Homestake Mining Co.
 Houston Natural Gas
 Hudson Bay
 Hughes Aircraft
 Humphries Enterprises
 Hunt Oil Co.
 Hydrocarbon Research, Inc.
 In-Situ, Inc.
 Ingersoll-Rand, Inc.
 Inspiration Consolidated Copper Co.
 Institute of Gas Technology
 International Coal Refining Co.
 International Minerals & Chemical Corp.
 Iowa Fuel and Minerals Co.
 Island Creek Coal Co.
 Jim Walter Resources, Inc. and Enhanced Energy Resources
 John Deere
 Jones & Laughlin Steel Co.
 Joy Manufacturing Co.
 Kennecott
 Kennecott Copper
 Kennecott Minerals Co.
 Kerr-McGee Coal Corp.
 King Knob Coal Co.
 Knife River Coal Co.
 Kopper's Co.
 L. John Minnick
 Livengood Joint Venture
 London-Virginia Mine
 Magma Copper Co.
 Marathon Oil Co.
 Massey Foundation
 McAlester Fuel Co.
 McConville Coal Co.
 McDonnell Douglas
 McIntyre Mines
 Meriden Engineering
 Mich Coal Co.
 Miller Construction Co.
 Minerals Corp.
 Minneapolis Electric Steel Castings
 Mississippi Corp.
 Mitchell Energy
 Mobil
 Mobil Coal Co.
 Mobil Petroleum
 Mobil Research and Development Corp.
 Mohawk Oil & Gas
 Monsanto
 Monterey Coal Co.
 Mountain Creek Mine
 N.L. Industries
 National Mines Corp.
 National Steel Corp.
 Nebraska Ash
 New York State Electric and Gas
 Newmont

Nickel Plate Coal Co.
 Nicor
 Noranda Lakeshore Mines, Inc.
 North American Coal Corp.
 North River Energy Co.
 North Star Steel Co.
 Occidental Research Corp.
 Oglebay Norton Co.
 Ohio Ferro Alloy Co.
 Pacific Foundation
 Panhandle Fly Ash
 Paraho Project
 Parker Mine
 Peabody Coal Co.
 Penn-Virginia Resources Corp.
 Pennzoil Producing Co.
 Pete Lien and Sons
 Phelps-Dodge Co.
 Phillips
 Phillips Coal
 Phillips Petroleum Co.
 Pickands-Mather Coal Co.
 Pittsburgh and Midway Coal Co.
 Pittston Coal Co.
 Placid Oil
 Plastic Techniques, Inc.
 Popp & Hawley
 Pozzolanic Eastern
 Pozzolanic Northwest
 PPA-Midwest
 Precision Blasting Co.
 Pyro Mining Co.
 Quality Coal Co.
 Quintana Minerals
 R.C. Baker Foundation
 Reichhold Chemical Co.
 Republic Steel Corp.
 Reserve Mining Co.
 Roberts and Schaefer Co.
 Rochester and Pittsburgh Coal Co.
 Rockwell International
 Sahara Coal Co.
 Sakrete
 Santa Fe Minerals
 Saskatchewan Power
 Science Support Program, ALCOA
 Scott-Ortec Co.
 Sharon Steel
 Shell Companies Foundation
 Shell Development Co.
 Shell Oil Companies
 Southeastern Fly Ash
 Southern Company Services
 Southern Ohio Coal Co.
 Southern Pacific Petroleum
 Southern Tube Corp.
 Southland Royalty
 Southwestern Illinois Coal Corp.
 Southwestern Public Utilities
 St. Joe Minerals
 Stan Graves Drilling and Coal
 Tech, Inc.
 Standard Oil
 Standard Oil of Indiana
 Star Coal Co. and Iowa Fuel and
 Minerals Co.
 Stockham Valve
 Stockton Gas Co.
 Sun
 Sun Production Co.
 Tenneco
 Tenneco Coal
 Tennessee Chemical Co.
 Texaco Research Co.
 Texas Gulf Corp.
 The Pittston Coal Group
 The Texaco Co.
 Thunder Basin Coal Co. (ARCO)
 TLT Babcock
 TOSCO
 Tri-Con Mining, Inc.
 Triton Coal Co.
 TRW
 Turris Coal Co.
 TVA
 U.S. Pipe and Foundry
 U.S. Steel Corp.
 Union Drilling
 United Nuclear Corp.
 Universal Oil Products Co.
 Utah International
 Valley Camp Coal Co.
 Versatile Products, Inc.
 Vicello-Grogan
 Vulcan Materials Co.
 W.M. Keck Foundation
 Walker and Walker
 Watson Foundation
 WEDCO
 Western Coal Co.
 Western Energy
 Westvaco
 Whirlpool
 WYODAK Resources
 Wyoming Fuel Co.
 Zeigler Coal Co.
 Zellars-Williams

APPENDIX II

PROGRAM OF RESEARCH AND EDUCATION
CONDUCTED BY THE
MINING AND MINERAL RESOURCES RESEARCH INSTITUTES
1982-1984

INTRODUCTION

This report provides information concerning activities and accomplishments of the Mineral Institute programs for the years 1982-1984. It serves to update the previously prepared five-year report: "Increasing Supply and Productivity in the Mineral Sector through Research and Education. A Five Year Record of Achievement (1978-1982)."

Included in the report are:

1. Listing of the Mineral Institutes
2. Profiles of Institute Programs
3. Research Programs of the Generic Minerals Technology Centers
4. Directors of the Mineral Institutes

Directors, Generic Mineral Technology Centers

Mine Systems Design and Ground Control

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Pyrometallurgy

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Comminution

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Mineral Industry Waste Treatment and Recovery

Dr. Ross W. Smith
Professor and Director Mineral Industry GMTC
Department of Chemical and Metallurgical Engineering
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Respirable Dust

Mr. Robert L. Frantz, Head
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104 Mineral Sciences Building
Pennsylvania State University
University Park, PA 16802
Phone (814) 863-1617

STATE MINING AND MINERALS RESOURCES RESEARCH INSTITUTES

Mineral Institutes have been established at universities in the following states:

Alabama	Louisiana	Ohio
Alaska	Massachusetts	Oklahoma
Arizona	Michigan	Pennsylvania
California	Minnesota	South Dakota
Colorado	Mississippi	Texas
Georgia	Missouri	Utah
Idaho	Montana	Virginia
Illinois	Nevada	Washington
Indiana	New Mexico	West Virginia
Iowa	North Dakota	Wyoming
Kentucky		

Profiles of the institute programs are given on the following pages.

Alabama - Institute Profile
(1982-84)

Director R. Bruce Tippin
Alabama Mining and Mineral Resources Research Institute
P.O. Drawer AY
University of Alabama
University, (Tuscaloosa) Alabama 35486

Activities (average number per year):

Research projects	12
Faculty support	12
Student support	
Undergraduate	8
Graduate	6

Total Value of Equipment Purchased \$234,000

Industrial Support for scholarships,
fellowships and assistantships \$ 85,000

Industrial Impacts:

Reconnaissance and Processing of Impounded Fine Coal Wastes:

Forty impoundments at 20 sites in the state were sample and mapped. As a result, fine coal now is being recovered by three companies from their waste impoundments and similar plans are underway by several other companies

Coalbed Methane in Alabama:

Test Methane producing coreholes, from coal seams, have been drilled to depths of 2800 and 3400 feet. A total of about 200 million cubic feet of gas is potentially available from each forty acre tract in a large portion of the research area. Two demonstration wells, funded in part by the American Public Gas Association, has been completed on the University campus. These wells will produce gas for operating a test fuel cell to supply electricity for the University Student Recreation Center.

Other Beneficial Impacts:

The Institute provided instructional assistance to the Department of Mineral, Geology and Chemical/Metallurgical Engineering, student employment, and equipment purchases in virtually all parts of the university. The publication of results from Institute research on mineral-related activities were important service functions of the Institute. Workshops, symposia, conferences, and short courses were conducted on mineral and energy subjects. Specialized training has been provided to students, staff and faculty on equipment and computers.

Assistance in solving difficult research and development problems was provided to industry. For example, research studying the impact of surface coal mine blasting on contiguous underground operations proved that surface mine blasting, when properly conducted, could be carried out safely in closer proximity to underground operations than allowed by law. Based on the Institute research, the U.S. Office of Surface Mining granted a waiver to the operators permitting a closer blasting scale distance thereby substantially increasing coal production capacity. It is estimated that the modified regulations will permit the recovery of about 20 million tons of coal worth about \$500 million which previously was not mineable. Publication describing the blasting study data has been requested from 20 states and 5 countries.

Alaska - Institute Profile
(1982 - 84)

Director David R. Maneval
School of Mineral Engineering
University of Alaska
Fairbanks, Alaska 99701

Activities (average number per year)

Research projects	5
Faculty support	6
Student support:	
Graduate only	5

Total Value of Equipment Purchased \$5,000

Industrial Impacts

1. Application of Hydrocyclones for Recovery of Fine Gold from Placer Material

A system using hydrocyclones was developed and found to be practical in recovery of fine placer gold. The system is designed to be easily disassembled and moved for field installation. Potential users include not only the 450 active placer miners in Alaska, but also placer miners world wide.

2. Application of Seismic Refraction and Electric Resistivity Methods in Placer Exploration

The presence of permafrost and the complicated interpretation procedures of conventional geophysical methods in subsurface exploration lead to the development of an improved seismic and electric method to locate gold deposits. Two computer programs were developed and are now being used to assist in field data interpretation.

3. Multiphase equilibrium of natural gas hydrates with and without the presence of inhibitors

The effect of salt solution on the ratio of gas molecules to water molecules in crystalline hydrate structures was examined. The data produced by this study are proving beneficial in the planning of gas recovery from Alaskas North Slope gas and oil fields.

Other Beneficial Impacts:

The Institute provides a mining and ore testing program in Interior and Central Alaska. A newly constructed 2,000 square foot facility is to be used to crush, grind, prepare rocks for the mining community, interested members of the public, and local students. The professional staff and faculty of the School of Mineral Engineering pay an annual visit to all high schools accessible by road to deliver talks on the importance of mines and minerals in today's society. Initiated annual Placer conference (1978) with MMRPI funding. Three day MIREL conference (1984) with 600 attendees.

Arizona - Institute Profile
(1978-84)

Director, J. Brent Hiskey
University of Arizona - MMRI
Room 17A - Arid Lands Bldg.
845 N. Park Avenue
Tucson, Arizona 85719

Activities (average number per year):

Research projects	4	Student support	
Faculty support	5	Undergraduate	3
		Graduate	15

Post Doctoral 1

Total Value of Equipment Purchased by MMRI \$118,000

Industrial Support for scholarships, fellowships and assistantships \$235,000 per year until 1982
\$145,000 in recent years

Industrial Impacts:

1. Ground and Air Vibrations Caused by Surface Blasting; Jaak J. K. Daemen et.al. 1983. In this two year study of vibrations induced by large surface blasts, new methods were developed for predicting resultant vibrations. These analytical predictors are a consistent improvement over conventional scaled distance predictors and provide both Industry and Government with useful approaches to planning and executing blasting operations within economic and public safety limitations.
2. Smelter Emission Controls: The Impact on Mining and Market of Resultant Sulfuric Acid; Michael Rieber, 1982. The economic impact of production of vast amounts of Sulfuric acid during copper smelter production has a profound effect on the continued operation. Five smelters were expected to close. With the added impact of low level copper prices on the world market, all five of these American smelters have closed, and now the major question is whether or not they will reopen. The loss of national capability needs economic re-study to determine action to be taken.
3. Inventory of Hazards Monitoring of Mineral Lands Using Satellite Imagery; Charles Glass, 1981. A highly effective and useful method has been established, wherein remote sensing allows the assessment of environmental hazards due to mining operations in Arizona. With the development of these procedures an effective and trustworthy approach exists for monitoring risks to public safety and incorporating this information into the plans for continued industrial operations and reclamation.

Other Beneficial Impacts:

During a period of depressed Industrial funding of research and student support, the MMRI program of funding start-up research projects of faculty of the College of Mines has had a major impact on continued research which is so vital to modern education in mineral resource engineering and science. During the past three years thirteen faculty and twenty students have been involved in important Developmental Research projects as an additive to other projects in the college. The attraction of high quality students to mineral resource graduate degree programs has been aided by MMRI fellowships.

California - Institute Profile
(1982-84)

Director Douglas W. Fuerstenau
University of California
Hearst Mining Building
Berkeley, California 94720

<u>Activities (average number per year)</u>		<u>Student support:</u>	
Research projects	12	Undergraduate	8
Faculty support (indirect)	9	Graduate	12
		Postdoctorals	1

Total value of equipment purchased: \$35,537

Industrial support for scholarships, fellowships and assistantships: \$122,000 per year

Industrial Impacts

1. Cross-Hole Seismology for Monitoring Rock Masses

In order to develop a remote geophysical technique to survey and monitor rock masses from boreholes, analysis and evaluation of cross-hole seismic data for the characterization of rock masses was undertaken at Berkeley. A high-frequency seismic technique proved effective in outlining zones with an abundance of open fractures or fractures filled with weak infilling material. The petroleum industry is now actively investigating possible applications in oil well assessment. An important application for the technique is in the program for the storage of high-level nuclear wastes. The technique could also be utilized for stress and integrity monitoring in chambers for storage of heated oil and liquefied natural gas (LNG). For the mining industry a potential application for this seismic tomography is in delineating veins with high grade ores between two boreholes.

2. Energy Reduction in Aluminum Electrolysis

A major research effort is concerned with the electromagnetically driven flow within the molten salt electrolyte and molten aluminum of the Hall cells used in the production of aluminum. Such cells consume approximately 5% of the electrical energy produced in the U.S., and the electromagnetically driven flow is known to detrimentally affect cell performance. A "cold" physical model (one-twelfth scale) has been built, using Wood's metal which flows under the influence of electromagnetic forces when current is passed through the cell. Velocity measurements give velocity values in rough agreement with the predictions of a mathematical model, developed at Berkeley, for melt flow in aluminum cells. Current work to study the effect of changing cell designs and operating parameters (involving the physical cell and the mathematical model) is receiving direct interaction with the aluminum industry.

Other Beneficial Impacts

The sharply growing mining activities in California add to the responsibilities of the MMRI and reinforce its importance to the State. The Berkeley Campus has long had a diverse program in various mineral engineering fields and the Institute has helped provide a focus for faculty teaching and research in these fields. The University of California at Berkeley is generally considered to be the overall premiere graduate institution in the United States, and the California MMRI has influenced the strengthening of Berkeley's graduate mineral engineering program. Berkeley researchers contribute immensely to symposia and publications in various aspects of mineral engineering. New faculty in other colleges and universities received their Ph.D. degrees from Berkeley mineral engineering programs.

Georgia - Institute Profile
(1982-84)

Director Eric J. Clayfield
Georgia Mining and Mineral Resources Institute
Georgia Institute of Technology
Atlanta, Georgia 30332-0101

Activities (average number per year):

Research projects	3
Faculty support	2
Student support	
Undergraduate	1
Graduate	3

Total value of equipment purchased: \$32,000

Industrial Impacts

Research activities were essentially directed towards problem areas which were of specific concern to Georgia mineral industries operations, and involved a wide variety of mining and mineral technologies. The required broad brush program of research was effectively developed by making appropriate use of the wide range of multidisciplinary expertise established within the College of Engineering schools at Georgia Tech. Projects of acknowledged industrial impact on-going or completed to final reporting stage this 1982-84 period included:- Computer Analysis and Prediction of Pit Slope Stability of Georgia Kaolin Mines; Design of Site Dewatering Systems; Potential Health Effects from Uranium in Georgia Phosphate Deposits; Landsat Imagery Search for Georgia Ultramafic Deposits; Georgia Kaolin as Potential Al Source; Crystal Structure of Zirconia/Yttria Compositions; Bauxite Residues Upgrading by Magnetic Separation; Ultrahard Surface Coatings for Comminution Systems. Resulting publications were 7 reports and 3 papers, excluding internal theses reporting.

Other Beneficial Impacts

With Eric Clayfield appointed GMMRI Director April 1984, a particular new emphasis was focused on the innovative application of surface science concepts to critical solid/liquid separation problems arising in mineral processing technology; his research in this area has resulted in 2 papers and 4 patents filed during this period and stimulated considerable industry interest in co-operative research developments.

A valued contribution, particularly appreciated by Georgia mineral companies, was the maintained activity of our mineral engineering education program in providing specialized training in mining and mineral disciplines directed towards the growing technology needs of modern mineral industry. High quality students, of 3.5 plus grade level, have been attracted to this study area to gain approved Mineral Engineering Certification.

Idaho - Institute Profile
1982-1984

Director: George A. Williams
College of Mines and Earth Resources
University of Idaho
Moscow, Idaho 83843

Activities (average number per year):

Research projects	24
Faculty support	4
Student support	
Undergraduate	1
Graduate	27

Total value of equipment purchased: \$53,000

Industrial support for scholarships,
fellowships and assistantships: \$40,000

Industrial Impacts:

1. Plasma Processing of Silver Concentrates

Several studies have been made on Coeur d'Alene ores to develop techniques of working the ores. One attempt is to develop a technique that will permit Bunker Hill to smelt ores. A paper was presented at Northwest Mining last fall in Spokane.

2. Recovery of Silver, Gallium and Other Valuable Metals from the Waste Dust Produced During the Manufacture of Elemental Phosphorous.

The process is now under tests by several of the mining companies.

Other Beneficial Impacts:

1. Legal Pitfalls in Mining.

This study resulted in the publication of a volume that has gone through two printings and is being revised.

2. Stratigraphic studies of Southeastern Idaho.

Several theses have developed in the Overthrust area southeast Idaho where major oil companies are drilling for petroleum.

3. Recent Trends in Marketing and Shipment of Mineral Concentrates in Western United States.

Several large cooperations have expressed an interest in the results of this study with possible financing for the development of company policy.

ILLINOIS MINING AND MINERAL RESOURCES
RESEARCH INSTITUTE
1982-1984

Director James H. Swisher
Illinois Mining and Mineral Resources Research Institute
Coal Research Center
Southern Illinois University
Carbondale, IL 62901

Activities for the Period:

Program Development Projects

Research Projects 13
Faculty Researchers 13
Total Grants Awarded: \$120,000

Graduate Fellowships and Undergraduate Scholarships Awards

Undergraduate Scholarships 7
Graduate Fellowships 11
Post-Doctoral Awards 5

Applications of Research:

Research conducted under the Mining and Mineral Institute programs during this period has led to improvement in industrial applications and safety standards such as:

1. Field Evaluation of a Newly Developed Continuous Mine Roof Monitor.
This research has provided an improved monitoring technique on such parameters as the rate of change in roof sag, tension in roof bolts, strata separation and tension in bottom layers of the roof. The evaluation will in turn lead to improved safety standards in underground coal mines.
2. Laser Pyrolysis of Coal for Gasification and Desulfurization.
Research results led to the development of a new method for the microscopic characterization of coal macerals by pulsed laser induced fluorescence. This work has paved the way for improved coal maceral characterization and analysis.
3. Production of Hydrogen from Aqueous Pyrite Slurries.
Research done in this area has led to improved understanding of the production of clean fuels by electrochemical oxidation of pyrite minerals in aqueous acidic electrolytes. This innovative, low-energy consumption method uses coal, an abundant, non-petroleum based feedstock as a starting material.
4. A Stochastic Approach to Design of Belt Haulage Systems for Underground Coal Mines.
An improved optimization technique was developed for use in the analysis and design of belt haulage systems for underground room-and-pillar coal mines.
5. An Atomization Process for Coal-Water Separation.
A new approach to the separation of coal particles from water was investigated. This improved Babington atomization process will vastly improve coal-water particle separation technology.

Indiana Institute Profile
(1982-84)

Activities (average number per year):

Research projects	5
Faculty support	5
Graduate student support	10

<u>Total value of equipment purchased:</u>	\$ 20,300 (Federal)
	63,900 (Non-federal)

<u>Industrial support for scholarships, fellowships and assistantships:</u>	204,600
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Industrial Impacts:

1. Depth Guides to Drill Targets in Hydrothermal Veins. Although geochemical surface sampling provides a basis for selecting strike intervals of interest, there has previously been no reliable method for estimating depth to an ore horizon. Fluid inclusions in crystals growing in the presence of both steam and liquid were studied to determine fluid temperature and vapor pressures of H_2O and CO_2 in samples spanning a large range of depths in hydrothermal veins. The measured gradients provide a guide to drilling depth below studied outcrop samples in adjacent unexplored veins.
2. Fracture Mechanics Properties of Indiana Coal Mine Roof Rocks. Conditions associated with roof failures are only partially understood and the predictive powers of current analytical models are limited. Ultimate failure often involves propagation of pre-existing cracks or joints, and the response of these discontinuities to changing stress state and the effects of time are important in understanding roof falls.

The goal of this project was to measure the fracture toughness of representative sandstones, siltstones and shales found associated with coalbearing strata of southern Indiana for both short and long-term loading. Tensile strengths and elastic constants are being measured. Based on these parameters a more refined model for roof beam failure will be developed.

Other Beneficial Impacts:

The Institute has been beneficial to the mining (coal, aggregate, and limestone) industries in the State of Indiana and also to the Division of Reclamation of the Department of Natural Resources by conducting research on seventeen mining and reclamation projects. These projects although largely funded by Institute funds, also involved the cooperation, assistance, and in some cases, limited financial support by the following companies and agencies: Amax Coal Company, Indianapolis; Old Ben Coal Company, Oakland City; Inland Steel Coal Company, Michigan City; Indiana Division of Reclamation; Indiana Division of Forestry; Martin Marietta Aggregates Company, Indianapolis; Western Indiana Gravel Company, West Lafayette; Indianapolis Department of Public Works, Indianapolis; Argonne National Laboratory, Argonne, Illinois; U. S. Army Corps of Engineers; and H. G. Acres - American Corporation.

Iowa - Institute Profile
(July 1982 - June 30, 1984)

Acting Director Richard Markuszewski
Iowa State Mining and Mineral Resources Research Institute
Iowa State University
Ames, Iowa 50011

Activities (average number per year):

Research projects	12
Faculty support	2
Student support	
Undergraduate	1
Graduate	10

Total value of equipment purchased: \$20,000

Industrial support for research: \$100,000

Industrial Impacts:

1. Recovery of Minerals from Power Plant Fly Ash by High-Temperature Chlorination

A process to extract valuable minerals, such as alumina, from a by-product of coal combustion is being developed, tested, and refined over the last several years as a promising method to aid public utilities in addressing problems of disposal of fly ash.

2. Apparatus for In-Situ Rock Strength Tests in Mine Workings

A working prototype of a borehole shear tester to measure stresses in rocks associated with underground roof bolting was successfully field-tested and subsequently patented for the U.S. Bureau of Mines.

3. Identification of Limestones Available Regionally for Use in Fluidized Bed Combustion

A compendium of chemical and physical properties of limestones, especially from Iowa, is being continually updated for use by the limestone industry in order to identify deposits suitable for use as sorbents in fluidized bed combustion.

Other Beneficial Impacts:

1. Rapid Method to Analyze Coal and Coal-Derived Mineral Matter

Collaboration with a major chemical company is resulting in the development of a procedure to analyze quickly coal and coal-derived mineral matter for major, minor, and trace constituents, with possible applications for field use.

2. Utilization of Coal-Derived Fly Ash in Combination with Mining Wastes

The cementitious nature of fly ash is being exploited for the preparation of concretes to stabilize soils and construct low-cost vaults for mine waste disposal. This partial solution to the growing problem of waste disposal is being tested in the laboratory for later transfer to the field and to industry.

Kentucky - Institute Profile
(1982-84)

Director Lyle V.A. Sendlein
Institute for Mining and Minerals Research
12 Porter Building
University of Kentucky
Lexington, Kentucky 40506-0205

Activities (average number per year):

Research projects	8	Student support	
Faculty support	12	Graduate	10
		Undergraduate	10
		(Additional 60 per year from matching state money)	

Total value of equipment purchased: \$35,000

Industrial support for scholarships, fellowships and assistantships: \$25,000 per year

Industrial Impacts:

1. Petroleum Geology of Kentucky

A report reviewing the petroleum geology of Kentucky had not been produced since 1943. This research provides a current summary of the petroleum geology of Kentucky and provides information on drilling regulations and practices in Kentucky. This report is a valuable reference guide for developing Kentucky's oil and natural gas resources.

2. Modeling Resuspension of Sediment in Surface Sediment Ponds

Computer models of sediment ponds were developed that consider the physical factors affecting trapping of sediment in detention ponds. These models predict the effluent settleable solids in a given storm.

3. Mining Engineering Continuing Education

An ongoing program which provides technical assistance, disseminates information and increases communication of research to the industry. Continuing education workshops and short courses have included: "Fundamentals of Roof Control and Pillar Design", "Chemistry of Coal Utilization" and "Coal Laboratory Technician Training".

4. Mineral Law Handbook

A comprehensive mineral law resources handbook based on Kentucky and national mineral law issues. This handbook treats environmental quality as well as the legal issues surrounding mining and mineral resources. A leading legal publisher has agreed to publish this report.

Other Beneficial Impacts

The IMMR continues to operate the Kentucky Center for Energy Research Laboratory, a state-owned and university operated research facility. Current research and technical service programs include synthetic fuels, oil shale, coal preparation, coal geoscience, environmental science, and atmospheric fluidized bed combustion.

Louisiana - Institute Profile
(1982 -84)

Director Ralph W. Pike
Mining and Mineral Resources Research Institute
Office of Research Coordination
Louisiana State University
118 David Boyd Hall
Baton Rouge, Louisiana 70803

Activities (average number per year):

Research projects	37
Faculty support	23
Student support	
Undergraduate	5
Graduate	39
Postdoctoral	0

Total value of equipment purchased: \$46,000

Industrial support for scholarships, fellowships and assistantships: \$60,000 per year

Industrial Impacts:

1. Sonic Burner for Increased Lignite Loadings in Lignite-Fuel Oil Mixtures in Commercial Furnaces

A new burner system (termed sonic burner) has been developed which increased lignite loadings from 35% (wt) to 60% (wt) of lignite in lignite-fuel oil mixtures in continuous tests in the five-million BTU/hr research combustion chamber. The burner system incorporated sonic fuel atomization and a single large diameter fuel opening at the exit. Flames produced were stable, compact and characteristic of those produced by No. 6 fuel oil. This research was performed in close cooperation with industry, and several firms assisted by furnishing burners and modifying designs. These results permit the use of the local lignite reserves in industrial and commercial furnaces.

2. In-Situ Oxidation and Alkaline Flooding for Enhanced Oil Recovery

It has been demonstrated experimentally under simulated reservoir conditions that in-situ air oxidation increased organic acid content of unacidic crudes which can then be reacted to form surfactants using a caustic flood. This chemical modification can improve the oil recovery from Gulf Coast reservoirs.

Other Beneficial Impacts

1. In the boiler efficiency improvements project, approximately 1,100 engineers plant managers and boiler operations have participated in a two day workshop covering numerous topics from a detailed manual on effective boiler operations. Also, more than 150 boiler efficiency field tests have been conducted.
2. In the mineral production information system project, detailed reports were issued on the following topics: Louisiana non-oil and gas mineral production statistics, Louisiana mineral producers statistics, geographic information guide, population studies model users guide and the natural resources source catalog.

Michigan - Institute Profile
(1982-84)

Director Lloyd A. Heldt
Center for Mining and Mineral Resources Research
Michigan Technological University
Houghton, Michigan 49931

Activities (average number per year):

Research projects	8
Faculty support	8
Student support	
Undergraduate	4
Graduate	4

Total value of equipment purchased: \$62,000

Industrial support for scholarships, fellowships and assistantships: \$70,000 per year

Industrial Impacts:

1. Analytical Systems for Mineral Processing

On-line systems, based on absorption of high energy radiation, have been developed to monitor mineral processing streams, particularly in coal preparation, where continuous sensing of ash content is critical for effective operation.

2. Improvements in Underground Blast Design

Blast design is assisted by the results of a study of the influence of stemming on blast vibrations. Correlation has been made between stemming length and stemming particle size distribution with roof vibration levels.

Other Beneficial Impacts:

Problems continue to occur in the vicinity of abandoned mines. In Michigan, and other states, progress has been made in mapping such areas, measuring progressive subsidence and recommending measures to be taken to deal with shaft failures, and mine water drainage.

An experimental mine, near campus, is well developed and is serving as a test site for studies of blasting, diesel engine emissions, and rock mechanics. Several underground classrooms are employed for instructional use.

Minnesota - Institute Profile
(1982-84)

Director: Kenneth J. Reid
Mineral Resources Research Center
University of Minnesota
Minneapolis, Minnesota 55455

Activities (average number per year):

Research projects	6	Student support: Graduate	6
Faculty support	4	Undergraduate	2
		Postdoctoral	2

Total value of equipment purchased: \$35,000

Industrial support for Scholarships, fellowships and assistantships: \$56,000 per year

Industrial Impacts:

1. **National Workshop:** MRRC organized a National Workshop held in May 1984 with representatives from Industry, Government, and Mineral Institutes to explore "The Role of University Mineral Institutes and Industry in a Coordinated National Mineral Research Program". Committees were formed to initiate needed links for inter-Institute and Institute-Industry communication. Proceedings of the workshop are available on request from MRRC.

2. **Plasma Metallurgy:** In the last two years a unique plasma laboratory initiated in 1979 with Mineral Institute support has grown into an internationally recognized facility with projects in iron ore and chromite reduction and in novel cement technology. Cooperation with U. S. and international companies and laboratories has been established. The director was invited to give a plenary address on Plasma Metallurgy at an international conference in Johannesburg in March 1984.

Other Beneficial Impacts:

A state workshop to address Mineral Resources Research needs in Minnesota was held on the Mesabi Iron Range and was attended by participants from industry, state and local government and the university. 78 topics of concern were developed covering both short term and long term problems in mining, processing and communication and organization. Of these, 14 were addressed in group sessions. The proceedings have served to define the main research needs of the state and provide a basis for research program development and funding. A continuing workshop series has been initiated to focus on particular areas in more detail.

Advanced analytical capabilities are an important part of mineral resources research and MRRC has an aggressive program for the acquisition and development of state of the art systems. In one project a scanning ion probe is being coupled to a Tandem Van de Graff accelerator to provide an accelerator mass spectrometry system at the leading edge of technical advances in the field. There are no known similar developments in USA and only 2 others internationally. The system will be of value for trace element analysis both in minerals e.g., Platinum Group Metals and for impurity detection in ultra pure semiconductor materials.

Mississippi - Institute Profile
1982-84

Dr. James R. Woolsey, Director
The Mississippi Mineral Resources Institute
The University of Mississippi
University, Mississippi 38677

Activities:

Federal Allotment Research Projects	14
State Funded Research Projects	18
Faculty Support	22
Student Support - Graduate	42

Total value of equipment purchased: \$ 9,500

Other support (staff research):

NOAA	55,832
United Nations Revolving Fund	163,350
U. S. Dept. of Interior	38,000
Industry	<u>10,000</u>
Total other support	\$267,182

Industrial Impacts:

1. Landsat Laboratory

Developed methodology for better defining structural patterns which has aided in the location of 25 successful oil and gas wells in the United States and of a major tin deposit in Brazil.

2. Gravel Barging

Market analyses along inter-coastal waterway in southern Louisiana and southeastern Texas has prompted producer interest. Barging will likely begin in the near future.

Other Beneficial Impacts:

1. Phosphate Exploration and Beneficiation

Exploration off the coast of the Peoples Republic of the Congo indicated reserves suitable for local use. Beneficiation research developed successful technology for separation of shell from phosphorite.

2. Offshore Drill Sampling Technology

Designed and perfected a drill sampling system that dramatically reduces offshore placer mineral exploration and evaluation cost.

3. Lignite

Research on beneficiation has provided techniques for upgrading the quality, which may stimulate utilization.

Missouri - Institute Profile
(1982-1984)

Director David J. Barr
Missouri Mining and Mineral Resources Research Institute
University of Missouri-Rolla
Rolla, Missouri 65401

Activities (average number per year):

Research Projects	10
Faculty Support	4
Graduate Student Support	10

Total value of equipment purchased: \$ 39,946

Industrial support for scholarships,
fellowships and assistantships: \$164,005

Industrial Impacts:

1. Metallurgical Processing Characteristics of Galena

Research into the hydrophilicity of lead ore is being conducted in conjunction with metallurgists of the St. Joe Lead Company. Results may lead to better, more efficient milling. There will be benefits to companies operating in the Missouri Lead Belt.

2. Coal Desulfurization

Investigations continue into methods for removing a portion of the sulfur commonly found in Illinoian Basin Coal. Satisfactory results could lead to increased utilization of Missouri Coal.

3. Mineralogy, Paragenesis, Geochemistry and Isotope Ratios of the Cobalt and Nickel Minerals of the Mississippi Valley-Type Deposits in Fredericktown, Missouri

There has been industrial interest in the results of this study leading to renewed exploration for economic deposits of this strategically critical mineral.

Other Beneficial Impacts:

1. Geostatistical Modeling

Several projects utilize geostatistics for development of more economical mining methods. These techniques are significant for both hard-rock and coal mining.

2. Regionalized Modeling of Hydrocarbon Trends

Investigation into the location and methods for extracting heavy (viscous) crude oil may lead to increased production and utilization of this energy resource.

NEVADA-INSTITUTE PROFILE

(1982-1984)

Director: James L. Hendrix
 Mackay Minerals Research Institute
 Mackay School of Mines
 Reno, Nevada 89557

Activities (average number per year):

Faculty support	2
Student support:	
Undergraduate	30
Graduate	13
Postdoctoral	1

Total value of equipment purchased: \$20,000

Industrial support for scholarships, fellowships and assistantships: \$50,000 per year

Industrial Impacts:

1. Development of a Management Information System for Small Mining Operations Using a Microcomputer System.

This particular project has received wide support within the mining community in the State of Nevada. Many companies have participated in the development of the system.

2. Studies Concerning the Metallurgy of Gold

The Institute has carried out a series of studies concerned with the lesser used lixiviants for the leaching of gold. Extensive studies using thiourea and ammonium thiosulfate have been conducted. Many companies have solicited the Institute to evaluate these reagents as potential lixiviants.

Other Beneficial Impacts:

Other beneficial impacts of the MMRI program include:

Leverage with industrial concerns for fund raising activities; enhancement of campus, state and industry perception of Mackay School of Mines; travel opportunities for faculty and students to professional meetings; enhanced recruiting opportunities.

Of special note is the flexibility in research that our long time established School of Mines has gained by the use of research assistantships and fellowships funded by MMRI monies. New ideas can be pursued, as well as new faculty assisted in establishing their research program by the availability of MMRI fellows.

New Mexico - Institute Profile
(1982-84)

Director Arpad E. Torma
State Mining and Minerals Resources Research Institute
New Mexico Institute of Mining and Technology
Socorro, New Mexico 87801

Activities (average number per year)

Research projects	15
Student Support	
Undergraduate	8
Graduate	5

Total value of equipment purchased: \$37,533

Industrial Support for Scholarships: \$92,000

Industrial Impacts:

Gases in Hydrous Minerals (IRG): A firm was organized to perform ore analysis by determining gas content of hydrous minerals.

Other Beneficial Impacts:

Several studies funded through the Mineral Institute explored environmentally safe leaching techniques for such metals as gold, silver, copper and uranium. Bacterial leaching techniques could prove valuable in processing low-grade and waste materials now unretrievable. Another study ("Extraction of radionuclides from low-grade ores and mill tailings" - IRG) demonstrated that hazardous wastes could be rendered innocuous. These projects provide information which would directly benefit the mining industry, both large- and small-scale, of New Mexico.

Of further possible commercial interest, were studies on assay procedures using L x-rays (of potential benefit to the uranium fuel cycle from exploration to waste control) and on quantitative comparisons of the infra-red spectra of coals (commercially important properties of whole coals can be rapidly characterized from the information provided by infrared spectra analysis)

Equipment purchased through Mineral Institute grants was also instrumental in attracting more research grants, both from government and industry. One such project was the Portable Generator purchased by the Mining Department, which was on hand for research funded by two mining companies on high speed filming of rock blasting and fragmentation. The Pressure Membrane Extractor in the Geoscience Department aided in funding a number of subsequent research projects in hydrology, as it was available when proposals were submitted (one project funded for 50k and one for 100k).

The Mineral Institute at NMIMT has assumed an important role in mineral-oriented research and educational training, and has strengthened the mission of NMIMT, as well as benefiting the mining and exploration industries of New Mexico.

NORTH DAKOTA - INSTITUTE PROFILE
(1982 - 84)

Director Gerald H. Groenewold
Mining and Mineral Resources
Research Institute
Box 8103, University Station
Grand Forks, North Dakota 58202

Activities (average annual number per year):

Research projects	11
Faculty support	7.5
Student support	
Undergraduate	1
Graduate	9
Postdoctoral	1

Total value of equipment purchased: \$ 2,000

Industrial support for scholarships,
fellowships and assistants: \$27,000 per year

Industrial Impacts:

1. Investigation of the Environmental Effects of Disposal of Fly Ash and Flue Gas Desulfurization Waste in a Surface Lignite Mine

This project is the most detailed and long term field monitoring project of its kind in the U.S. The project is receiving international recognition. Data generated by this project are demonstrating that intrinsic attenuation mechanisms are operative in disposal-site sediments in this region. Project data are demonstrating that lining of disposal sites, as currently required in this state and much of this region, is generally not necessary. This has resulted in multi-million dollar savings for the industry.

2. Characterization, Extraction, and Reuse of Coal Gasification Solid Wastes

Detailed characterization and leaching studies of several ashes from fixed-bed gasifiers have been completed. These data indicate that the ash leachates do not exceed RCRA limits for hazardous wastes. These data allow industry an objective basis for evaluation of design requirements for disposal sites. In addition, several methodologies for bulk utilization of these wastes have been evaluated both from an engineering and economic standpoint. This study has indicated that these wastes can be utilized in bulk form in several applications and that the resultant products represent a significant cost savings relative to current similar commercial products.

Other Beneficial Impacts:

During the two-year period, the state's mining and energy resource companies, as well as state and federal agencies, became actively involved in the research and academic programs of the MMRI. This involvement included input into the design of those programs as well as active participation of industry and agency personnel in teaching. The mining engineering curriculum was significantly expanded.

During the two-year period, the North Dakota MMRI published forty-five (45) research reports and papers. In addition, the MMRI sponsored two national and one international symposia.

Oklahoma - Institute Profile
(1982-84)

Director Robert H. Arndt
Oklahoma Mining and Mineral Resources Research Institute
University of Oklahoma
830 Van Vleet Oval
Norman, Oklahoma 73019

Activities (average number per year):

Research projects	27
Faculty support	10
Student support	
Undergraduate	1
Graduate	26

Total value of equipment purchased: \$48,000

Industrial support for scholarships,
fellowships and assistantships:

None directly to Institute

Industrial Impacts:

1. Bacterial desulfurization of mineral materials

Development of a fermentation cell for continuous mass regeneration of *Thiobacillus ferrooxidans* in the presence of pyrite has attracted support from Air Products and Chemicals, Inc. of Allentown, Pennsylvania, for application in the experimental desulfurization of coal.

2. An emerging program in rock mechanics

A very large industrial firm has pledged \$600,000 to equip a rock mechanics laboratory in the University's new Energy Research Center, which is under construction. The Institute has given strong support to the program.

Other Beneficial Impacts:

1. Origin and emplacement of critical and strategic metals.

Significant new knowledge about ore deposits of lithium, beryllium, tin, tungsten, niobium, tantalum and molybdenum has been established. The knowledge is highly applicable in exploration for ore deposits.

2. Enhanced recovery of oil with surfactants

Knowledge of basic chemical and engineering aspects of the liquid to liquid and liquid to solid relationships has been widely expanded through basic research in chemistry and chemical engineering.

3. Legal conflicts between mineral estate and surface estate

A systematic compilation of common law, statutes and regulatory practices in Oklahoma indicates that equality between the estates has been essentially achieved in respect to oil and gas. The conflict remains largely unresolved in respect to the mining of nonfuel minerals, except in the presence of specific agreements between participants.

Pennsylvania - Institute Profile
(1982-84)

Director Z. T. Bieniawski
Pennsylvania Mining and Mineral
Resources Research Institute
The Pennsylvania State University
University Park, PA 16802

Activities (average number per year):

Research Projects	5
Faculty Support (Research Initiation)	11
Student Support	
Undergraduate	6
Graduate	12

Total Value of Equipment Purchased: \$29,477

Industrial Support for Scholarships,
Fellowships and Assistantships: \$94,125/year

Industrial Impacts:

• Enhanced Oil Recovery by Liquid CO₂ Flooding

Three separate areas of study initiated on liquid CO₂ injection, in parallel with pilot tests being conducted in the field, are developing the data necessary to predict favorable oil response. This technology could recover up to 15 billion barrels of incremental oil.

• SPOT Assisted Monitoring of Discharge

A comparison of the accuracy of LANDSAT-3 with that of simulated-SPOT classification is being completed. The use of these improved remotely sensed hydrologic data to monitor ground features should lead to greater reclamation success, hence opening currently sensitive areas to resource development.

Other Beneficial Impacts:

The PA MRI base funding (and matching component) for equipment and research initiation resulted in

- a 3-year National Science Foundation Grant on "Electrochemistry of Sulfide Mineral Depression"
- successfully competing for a research contract from the U.S. Army Corps of Engineers on "A Numerical Computer Model and Other Studies Related to Dustpan Dredging"
- a 3-year Department of Energy Grant on "Fundamental Studies of Bulk Flow of Fine Coals"
- a 3-year National Science Foundation Grant on "Industry/University Cooperative Research Activity: Heavy Media Separations"

South Dakota - Institute Profile
(1982-84)

Director: R. Norman Orava
Mining and Mineral Resources Research Institute
South Dakota School of Mine and Technology
Rapid City, South Dakota 57701-3995 Telephone: 605-394-2497

Activities (average number per year):

Research projects	14
Faculty support	7
Student support	
Undergraduate	2
Graduate	9

Total value of equipment purchased: \$62,900

Industrial support for scholarships, fellowships, and assistantships: \$ 58,545

Major Accomplishments

- Evaluated the feasibility of thick-seam underground mining of Powder River Basin coal. Sublevel longwall caving, used in Europe, may improve recovery and economic prospects for underground mining of thick coal seams in the Basin.
- Developed a method for measuring rock strength in the field permitting, for example, in situ evaluation of mine supports and field characterization of drill cores.
- Made significant advances in fine-particle recovery processes, in the recovery of copper as chalcopyrite and chrysocolla, and in the separation of cobalt from nickel thereby enhancing recovery of both metals from ores.
- Initiated a multidisciplinary program of research on low-rank western coals and established the Coal Research Laboratory.
- Determined that Wyodak coals do not contain levels of toxic elements which have previously been a cause for alarm in the use of these coals. Moreover, it was found that Wyodak coals contain hydrogen-rich constituents which makes them excellent synfuel feed stock. In summary, Wyodak coals appear to have some very attractive heretofore unrecognized properties.
- Determined that the unusual compositions and environments of deposition of coals in Lauderdale County, Tennessee, render them useless exploration targets and virtually uneconomical for commercial utilization.
- Established, at the SDSM&T, the Institute for the Study of Mineral Deposits which currently has \$474,000 in external sponsorship for mineral resources research.
- Initiated the Ph.D. program in Materials Engineering and Science thereby improving the longer-term continuity of research in mineral processing as well as in several other disciplines.

Texas - Institute Profile
(1982-84)

Director Jonathan G. Price
Bureau of Economic Geology
The University of Texas at Austin
Austin, Texas 78713-7508

Activities (average number per year):

Research projects	14
Faculty support	5
Student support	
Undergraduate	2
Graduate	16

Industrial Impacts:

1. Exploration for Mineral Deposits

Mineral Institute-supported research on ore deposits has led to new exploration concepts for silver-copper deposits in sandstones and for gold-silver veins in volcanic rocks. A Mineral Institute-funded report that provides geological and mine-production data on all known mineral deposits in far western Texas has stimulated industrial exploration.

2. Coal Resources

Assessment of Texas lignite and bituminous coal resources is continuing. Subsurface mapping and ground-water modeling are showing that certain hydrogeological environments are more favorable for deeper mining. Mineral Institute funding for this research is helping to identify those areas of most efficiently and profitably exploitable resources.

Other Beneficial Impacts:

1. Unconventional Mining Technologies

In situ leaching, or solution mining, of uranium, a technology developed in the 1970's, has proved to be economical even though recent market conditions have forced the closure of many domestic mines. Research on solution mines in South Texas has demonstrated the need for careful geological studies to select the most suitable areas for in situ leaching.

2. Training and Education

The Mineral Institute continues to support training of mining personnel through graduate fellowships, research assistantships, and undergraduate scholarships. Students are supported in engineering and geology departments at both The University of Texas at Austin and Texas A & M University. The Mineral Institute has taken the lead in establishing an innovative, multidisciplinary master's degree program in mineral economics.

Utah - Institute Profile
(July 1, 1982 - June 30, 1984)

Director Ferron A. Olson
Mining and Mineral Resources Research Institute
University of Utah
201 Applied Research Building
Salt Lake City, Utah 84112

Activities (Average number per year):

Research Projects	12
Faculty support	0
Student support	
Undergraduate	10
Graduate	15

Total value of equipment purchased: \$22,725

Industrial support for scholarships,
fellowships and assistantships: \$30,707

Industrial Impacts:

1. Air Sparged Hydrocyclone

An air sparged hydrocyclone with promise of savings in space and capital costs is now being tested by industry on a pilot plant scale.

2. Coal Mine Management Practices

This study shows that recent coal mine productivity increases are due to economic factors and will likely not continue unless better management practices are developed and used. In particular, mine managers must improve communication with the labor force and establish value systems that reach from management into the work force.

3. Computer Algorithm for Equipment Dispatching

A newly developed computerized algorithm for dispatching of trucks and shovels in open pit mines can show whether or not savings can be made using this type of dispatching as compared to the manual technique used today.

Other Beneficial Impacts:

1. Electrochemical Leaching of Sulfide Ores

The electrochemistry of sulfide mineral leaching has been developed for the minerals galena, chalcopyrite and covellite to help develop better leaching processes.

2. Electrowinning of Gold

A fundamental comparison of a commercial gold electrowinning cell (Zadra) with one using a fluidized bed electrode (FBE) shows that the FBE would require one fourth the volume of the Zadra cell for equivalent throughput but require higher gold inventory and closer process control.

Virginia - Institute Profile
(1982-84)

Director: Paul E. Torgersen
Dean, College of Engineering
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

Activities (average number per year):

Research projects	13 ("allotment" + "research" projects)
Faculty support	15
Student support	
Undergraduate	5
Graduate	13

Total value of equipment purchased: \$62,600

Industrial support for scholarships, fellowships and assistantships: \$50,000 per year

Industrial Impacts:

1. Coal Bump - Dr. Gavin Faulkner, a faculty member in the department of Mining and Minerals Engineering, is working with Island Creek Coal Company to discover how the mining industry might better resolve problems caused by "coal bumps." The mining industry has become increasingly concerned about the occurrence of coal bumps because of two recent incidents in West Virginia which resulted in fatalities.
2. Powell River Project - a close-cooperation venture with industry (Penn-Virginia Company) involving a number of mining companies, Virginia Tech, the state of Virginia and the Office of Surface Mining in advancing the technology involved in the surface mining and surface effects of the underground mining of coal.

Other Beneficial Impacts

1. A Study of Caving Characteristics above Mined Panels - efforts at improving mine safety were undertaken by critically evaluating the most established methods of roof caveability and examining their applicability to the caving characteristics in longwall and room-and-pillar operations in Appalachia.
2. Ground Control Mechanisms in Multi-Seam Mining - analysis of field data and model studies has shown that when mining under existing workings, innerburden-thickness and physical characteristics place determinable limits on effective interaction. Two masters students completed their program under this project.
3. Probabilistic Modeling of Soil Loss from Surface-Mined Areas - a project which developed a probabilistic model to describe the factors affecting sediment control alternatives for the design of surface-mined areas.

As evidence of its strong commitment to the MMRRI program, the commonwealth of Virginia each year has appropriated as a line item in the budget the amount required to serve as matching funds.

West Virginia - Institute Profile
(1982-84)

Director Richard A. Bajura
West Virginia University
Mining and Mineral Resources Research Institute
Morgantown, West Virginia 26506

Activities (average number per year):

Research projects	12
Faculty supported	12
Student support	
Undergraduate	2
Graduate	12

Total value of equipment purchased:

-0-

Industrial support for scholarships,
fellowships and assistantships:

\$35,000

Industrial Impacts:

1. Back Injury Reduction through Ergonomic Job Design - identify job or equipment design changes to reduce stresses on employees and reduce job injuries.
2. Electrochemical Neutralization of an On-Site Mine Drainage Pond - use concept of electrical battery to reduce hydrogen ions to acceptable levels in impoundments.
3. Expert Systems in Coal Mining - create an "Intelligent Computer System" to serve as an aid to decision making in all aspects of mining.
4. Optimum Mining Plan for Multiple Seam Mining - reduces mining costs and improves resource recovery for multiple seam mining while improving the levels of production and safety.

Other Beneficial Impacts:

1. Subsidence Effects on Structures in West Virginia - develop guidelines for structures built on undermined land and develop recommendations for structural rehabilitation.
2. Coal Mine Fires and Explosions - develop model for correlating the effects of explosions in model mine simulations versus real mine atmospheres.
3. Modelling Approach to Coal Policy Analysis in West Virginia - analyze the impact of the coal mining industry on the economy of the state and region.

Wyoming - Institute Profile
(1982-84)

Director Robert D. Gunn
P.O. Box 3295
University of Wyoming
University Station
Laramie, Wyoming 82071

Activities (average number per year):

Research projects	10
Faculty support	6
Student support	
Undergraduate	3
Graduate	10

Total value of equipment purchased: \$100,000

Industrial support for scholarships, fellowships and assistantships: \$25,000 per year

Industrial Impacts:

1. Research at the WMMRRI has shown that enhanced oil recovery in Wyoming can lead to the recovery of an additional 2.2 billion barrels of oil valued at about \$60 billion.

2. In Situ Inc. is a high-tech company based in Laramie and employing about 35 full-time personnel. The company is a spin-off of research partially funded by WMMRRI at a time when the company president, Dr. Chester A. McKee, was a faculty member at the University and a member of WMMRRI.

Other Beneficial Impacts:

1. The major development in the past year in the Wyoming Mining and Mineral Resources Research Institute (WMMRRI) has been the founding of the Enhanced Oil Recovery Institute. The WMMRRI has funded research projects on a seed money basis in the petroleum engineering field since the initial formation of the institute. As the department's research capabilities have become better known, the Wyoming State Legislature and the petroleum industry have recognized potential large benefits through the establishment of an even stronger research program in EOR (enhanced oil recovery). Accordingly, the EOR Institute was established by the Wyoming State Legislature and funded initially at the rate of \$223,400 for the first biennium.

2. During the past year, the ten members of WMMRRI have published 33 technical research papers, presented 16 research papers at national meetings of several engineering societies and have taught short courses in their areas of expertise to industrial personnel in the United States, Columbia, Singapore and Indonesia.

3. Nine students were able to pursue advanced degrees in the mineral engineering division through research assistantships provided by WMMRRI.

GENERIC MINERAL TECHNOLOGY CENTERS

The following centers have been established:

<u>Research Area</u>	<u>Lead Institution</u>
Respirable Dust	Pennsylvania State University/ West Virginia University
Mine Systems Design and Ground Control	Virginia Polytechnic Institute and State University
Mineral Industry Waste Treatment and Recovery	University of Nevada - Reno
Pyrometallurgy	University of Missouri - Rolla
Comminution	University of Utah

Although each center is located at a particular university, the research program also includes participation by other institutions on the focused activities of the Center programs.

Each center has an advisory committee, with strong representation from industry, which reviews proposed plans of research.

On the following pages are outlined the programs of the respective Centers.

GENERIC MINERAL TECHNOLOGY CENTER FOR RESPIRABLE DUST

DUST CENTER RESEARCH PROGRAM

The U.S. Bureau of Mines (USBM) established on August 15, 1983, a Generic Mineral Technology Center (GTC) for Respirable Dust within the Mining and Mineral Resources Research Institutes (MRIs) at The Pennsylvania State University (PSU) and West Virginia University (WVU) in association with participating MRIs at Massachusetts Institute of Technology (MIT) and the University of Minnesota (UMN). The Center's research program has been developed with recognition of the stated objective of the Federal Mine Safety and Health laws which is to "... permit each miner the opportunity to work underground during the period of his entire adult working life without incurring any disability from pneumoconiosis or any other occupation-related disease" The Center's program is designed to permit an accelerated attack on the fundamental research problems for the control of respirable dust in mines.

Significant progress has been made in lowering the dust levels in mines since the inception of the USBM respirable dust research program. It is generally agreed that mines are less dusty today than they were a decade ago. However, the most serious hazard for workers in the mining and minerals processing industries is still the exposure to respirable dust, and solutions to the problem of respirable dust remain to be found.

The primary goal of the Center is to reduce the incidence and severity of respirable dust disease through advancing the fundamental understanding of all aspects of respirable dust associated with mining and milling and the interaction of dust and lungs. The Generic Technology Center's research program explores these concerns with the objective of refining existing strategies and developing new respirable dust control techniques that are consistent with the fundamental dust-lung interaction processes that lead to mine worker disability. The work concentrates on (1) control of dust generation; (2) dilution, dispersion and collection in mine airways; (3) characterization of dust particles; (4) interaction of dust and lungs; and (5) relationship of mine environment, geology, and seam characteristics to dust generation and mobility. The fundamental aspects of this work are applicable to the control of respirable dust problems in both hard rock mines and coal mines and to other dusts such as diesel-generated. The Center activities involve the training of engineers and scientists, graduate students and undergraduate students through their respective institutions, and the technology transfer to the industry. The Center also serves as the reference center for publications in the respirable dust area.

The GTC is composed of faculty from PSU, WVU, UMN and MIT. The personnel, facilities and equipment that are available to the Center from these entities are diverse, complementary and comprehensive. Additionally, the expertise and facilities of the NIOSH - Division of Respirable Disease Studies are available as a result of the existing relationship between NIOSH and WVU. The breakdown of the dust research program into the five areas mentioned above recognizes the importance of an integrated fundamental research approach to the respirable dust problem compatible and complementary with the existing and ongoing U.S. Bureau of Mines activities. The specific projects in the research areas are a result of a careful evaluation of the past and ongoing research activities, the identification of areas where data and information are scarce, and awareness of the recommendation of the National Academy of Sciences (NAS) Study on the Measurement and Control of Respirable Dust.

GENERIC MINERAL TECHNOLOGY CENTER FOR RESPIRABLE DUST

LIST OF PROJECTS

Control of Dust Generation

- #4201/PS1 A Fracture Mechanics Study of Crack-Propagation Mechanism in Coal Utilizing Fracture Toughness and Fracture Velocity Concepts
- #5401/WV1 An Experimental and Analytical Approach to Study the Mechanisms of Respirable Dust Generation and Entrainment

Dilution, Dispersion, and Collection of Dust

- #4202/PS2 Prediction of Ambient Dust Concentrations in Mine Atmospheres
- #4206/PS7 Computer Modeling of Longwall Face Ventilation
- #5402/WV2 Experimental Studies of Dispersion and Transport of Respirable Dusts in Mine Atmospheres
- #5403/WV3 Measurements and Construction of Dust Distribution Maps for Longwall Faces
- #2702/MN2 Experimental and Theoretical Aerodynamic Diameter Analysis of Coal Dust

Dust Characterization

- #4203/PS3 Characterization of Dust Particles
- #4207/PS8 Wetting Characteristics of Dust Particles in Relation to Dust Abatement
- #4208/PS9 Analysis of Coal Particles on a One-by-One Basis Using an Automated, Computer-Controlled SEM with X-ray Fluorescence
- #5404/WV4 General Support Characterization
- #5409/WV10 Magnetic Resonance Spectroscopic Characterization of Paramagnetic Irons and Free Radicals in Coal Dust, Black Lung Tissue and Lung Tissue Under Controlled Dust Exposure
- #2701/MN1 Coal Mine Dust Characterization

Dust Lung Interaction

- #4204/PS4 Characterization of the Mechanism of Lung Injury by Coal Mine Dusts
- #4209/PS10 Investigation of the Role of Polymorphonuclear Leukocytes (PMN's) in the Dust Lung Interaction
- #5407/WV8 Dust-Lung Interaction in Coal Miners
- #5405/WV5 Pulmonary Inhalation Toxicity of Respirable Coal Mine Dusts: A Morphometric Study
- #5408/WV9 Effects of Respirable Dust on the Release of Superoxide from Pulmonary Alveolar Macrophages

Relationship of Mine Environment, Geology and Seam Characteristics to Dust Generation and Mobility

- #4205/PS5 Establishment of Standard Procedures for Characterization of Respirable Coal Mine Dust Potential
- #5406/WV6 Correlations of Respirable Dust Characteristics to Coal Seams, Worker Positions and Mining Methods
- #2501/MT1 Respirable Dust Testing in Metal, Non-metal Mines and Metallurgical Operations

Coordination

- #4200/PS6 Information Exchange and Dissemination (Penn State)
- #5400/WV7 Information Exchange and Dissemination (West Virginia)

PROGRAM, GENERIC MINERAL TECHNOLOGY CENTER,
MINE SYSTEMS DESIGN AND GROUND CONTROL

Funded by the Bureau of Mines of the U. S. Department of the Interior, the Generic Mineral Technology Center, Mine Systems Design and Ground Control is headquartered at Virginia Polytechnic Institute and State University. The Center specializes in mine systems design and ground control, and is involved in many projects for improving the technology, design, health, safety and efficiency of the mining and mineral industries. It consists of six participating institutions: the Universities of Alabama, Alaska, Idaho, Kentucky, Nevada-Reno, and VPI & SU, which is the lead university.

Originally funded in 1982 for \$1 million by the Office of Mineral Institutes of the Bureau of Mines, the Generic Mineral Technology Center, now in its third year, has developed a research advisory council, a project review committee, and a library reference center to house copies of doctoral dissertations relevant to the work of the Center. Microform copies of U. S. Bureau of Mines publications are now being processed into the collection and two online literature searches have been completed. Twenty-two technical research projects are currently active at the six participating universities.

The universities have composed a comprehensive, cohesive and diversified program during the Center's existence to reflect the many facets of mining, including mining exploration, evaluation, extraction, conservation and the environment. The major goal of the Center's research activities is to produce the geological environment and the ground control/operational systems interface necessary to optimize production and safety at minimum cost. Other goals are exploration, rock characterization, ground control/systems interface, systems simulation, innovative systems, production planning and control, environmental considerations, and systems/orebody integration.

The Center conducts an annual workshop, partially funded by the Office of Minerals Institutes, which has the following objectives:

1. To disseminate the progress of the principal investigators and their associates in the six participating universities in pursuing technical research projects. All principal investigators are invited to present papers outlining the progress of their research projects.
2. To give emphasis to the research efforts being undertaken by the Generic Mineral Technology Center.
3. To develop the annual report of the Generic Mineral Technology Center as a published Proceedings to be distributed to selected libraries and to be submitted to the Bureau of Mines as required by the grant agreement.

Quarterly technical progress reports are submitted to the Office of Minerals Institutes, U. S. Bureau of Mines, U. S. Department of the Interior. A complete listing of the current technical research projects is attached.

TECHNICAL RESEARCH PROJECTS. GENERIC MINERAL TECHNOLOGY CENTER.
MINE SYSTEMS DESIGN AND GROUND CONTROL

University of Alabama

1. Rock Characterization and Response in Deep Coal Mine Ground Control, D. W. Park
2. Subsidence Study of Alabama Coal Fields, D. W. Park
3. Economic/Safety Comparison Between Diesel and Electric Shuttle Cars in a Mine, T. Novak and H. Hartman

University of Alaska

4. Programmatic Thrust No. 1 Rock Characterization and Response, Optimization of Pillar Dimensions in a Permafrost Placer Mine, Scott L. Huang and Frank Skudrsky
5. Ground Control/System Interface -- In Situ Displacement Analysis of an Underground Opening in a Permafrost Region, Scott L. Huang and M. I. Johansen
6. Computer Simulation of Integrated Mining and Reclamation Operations of Sub-Arctic Surface Coal Mine, Sukumar Bandopadhyay
7. Environmentally Compatible Mining Operations Access Design in Permafrost Regions, Nils I. Johansen

University of Idaho

8. Mine Systems Design and Ground Control, J. R. Hoskins and C. J. Hall

University of Kentucky

9. Rock Characterization and Response -- Application of Ground Control Constraints in the Design of Mining Layout and Roof Support, K. F. Unrug
10. Identification of Roof Failure Mechanism in Coal Bearing Roof Strata, K. F. Unrug

University of Nevada, Reno

11. A Geostatistical Study to Determine Typical Parameters in Precious Metal Deposits in Western United States, P. Mousset-Jones and L. Kwa
12. Determination of Design Parameters for the Improved Planning of Airflow and Climate of Underground Mines, I, P. Mousset-Jones and M. McPherson
13. Determination of Design Parameters for the Improved Planning of Airflow and Climate of Underground Mines, II, P. Mousset-Jones and M. McPherson
14. An Investigation into the Use of Booster Fans Underground, M. McPherson and P. Mousset-Jones

Virginia Polytechnic Institute and State University

15. Identification and Application of Ground Control Parameters Pertaining to the Design of Mine Layouts, G. J. Faulkner
16. Integration of Ground Control and Systems Engineering Through Interactive Simulation, C. Haycocks
17. Computer Modeling and Simulation of Mining Systems, E. Topuz
18. Monitoring of Ground Control Parameters Associated with Longwall Mining, G. J. Faulkner
19. Ground Control Design Factors in Close-Proximity Multi-Seam Mining, C. Haycocks
20. Cavesability Characteristics of the Coal Measure Strata in the Appalachian Coalfield, M. Karmis
21. Response of Surface Structures and Ground Water Supplies in Areas of Mining Subsidence, M. Karmis
22. Investigation of Reinforced Timber Posts and Other Alternatives for Mine Roof Support, G. J. Faulkner

NEVADA
MINERAL INDUSTRY WASTE TREATMENT
& RECOVERY GENERIC CENTER

The Nevada "Mineral Industry Waste Treatment and Recovery Generic Center" was established in 1982 by a grant from the U.S. Bureau of Mines under the Mining and Mineral Resources Research Institute Program.

The overall programmatic thrust of the Center is focussed upon mineral industry waste treatment and disposal, and the recovery of critical materials from the waste products. The program emphasizes physical chemical information needed to evaluate the technical and economic viability of these processes. The Center also encourages participation from industry, the U.S. Bureau of Mines, and other mining and mineral resource research institutes.

In addition, it is the goal of the Center to train graduate mineral industry students. In most instances graduate students are able to use their generic center research projects as a basis for their graduate thesis work.

At the Mackay School of Mines, University of Nevada-Reno, there are a number of current waste treatment and recovery research projects. Faculty and graduate students from the Department of Chemical and Metallurgical Engineering and from the Department of Chemistry are involved with these projects. A mineral industry waste treatment and recovery reference center is also being established to serve as a repository for books and periodicals; these may be accessed by universities, industry, and government agencies.

In addition, satellite mineral industry waste treatment and recovery centers have been established at 1) the University of Idaho, 2) Montana College of Mineral Science and Technology, 3) New Mexico Institute of Mining and Technology, and 4) Iowa State University.

The subject matter of the Center is quite diverse, and at the Generic Center and its satellites researchers from a number of disciplines participate in the various research efforts. These disciplines at present include mineral processing, hydrometallurgy, pyrometallurgy, chemistry, mining hydrology and hydrology.

Integration of the various projects at the Center and its satellites is being attempted by several yearly meetings. One of these annual meetings is a seminar meeting where graduate students working on the projects report on progress of those projects to the participating researchers and other students.

GENERIC MINERAL TECHNOLOGY CENTER FOR MINERAL INDUSTRY
WASTE TREATMENT AND RECOVERY

List of Projects

UNIVERSITY OF NEVADA, RENO (only):	Project Director
Determination of Conditions and Rates for the Formation of Thiocyanates from Cyanides Associated with Gold Metallurgy	James L. Hendrix
Fundamental Studies on the Effects of Thiourea and Thioacetamide Addition on the Sulfide Precipitation of Heavy Metals	James L. Hendrix & John H. Nelson
Investigation of the Fate of Cyanide in Precious Metal Tailings Impoundments	James L. Hendrix & John H. Nelson
Recovery of Barite from Spent Drilling Muds	Ross W. Smith
Fluoride Wastes From Mineral Industry Processing Plants	Ross W. Smith
Recovery of Critical Metals From Non-Ferrous B.F. Slags	Ramana G. Reddy
Spent Strategic Metals Catalyst Recovery	Renato Bautista
Liquid Fluidized Bed Electrodeposition of Heavy Metals From Dilute Leach Solution and Effluents	Renato Bautista
Supercritical Extraction of Platinum Group Metals .	Renato Bautista

GENERIC MINERAL TECHNOLOGY CENTER FOR PYROMETALLURGY

Established in 1982 among the original five such centers, the Pyrometallurgy Center has two major purposes, namely, to enlarge the pool of people educated at the graduate level in pyrometallurgy, to conduct research on the improvement of existing high-temperature processes used to obtain and purify metals, and to seek new techniques for accomplishing these purposes. The University of Missouri-Rolla is the lead university, and has as affiliates Purdue University, Massachusetts Institute of Technology and the Ohio State University. Special projects are carried out under center auspices from time to time at other universities where unique expertise or equipment are available, and such projects are currently underway at Colorado School of Mines and the University of Minnesota.

The research performed under center auspices is basic in nature but has a practical orientation in that it is geared toward finding solutions to "real" problems. Research is active in improving three pyrometallurgical processes in current use commercially for producing metals, namely, smelting, refining and roasting; in exploring two newer extraction processes that show exceptional promise, namely, bath smelting in plasma-heated vessels, and the use of gas-bubble curtains to separate different chemical processes being conducted in the same vessel; and in studying the very bothersome inverse of an extraction process, environmentally-regulated oxidation. With few exceptions, all the projects involve one or more graduate students whose work on pyrometallurgy projects forms the basis for their graduate theses or dissertations.

Besides the two major functions described already, the center serves as a resource center for pyrometallurgy information. The Service for Pyrometallurgy Information (SPI), located at the University of Missouri-Rolla, provides rapid access through computerized databases to literature in the field published anywhere in the world. Although these databases can be searched only at the University of Missouri library now, remote dial-up access will be available in early 1986.

GENERIC MINERAL TECHNOLOGY CENTER FOR PYROMETALLURGY

Projects:University of Missouri-Rolla

Service for Pyrometallurgy Information (Weart)	2900
Thermodynamics of Pyrometallurgical Processing of Complex Materials (Morris)	2901
Smelting & Refining: Injection of Gases & Solids (Crimes)	2902/2906
Oxidation & Pyrophoricity (Crimes)	2903
Bath Smelting (Morris)	2907
Process Mineralogy of Pyrometallurgical Feeds (Hagni)	2908

Purdue University

Complex Ore Refining (Gaskell)	1801
Smelting and Refining: Slags & Mattes (Gaskell)	1802
Gas-Solid Reactions: Pyrophoricity (Spitzer)	1803
Vacuum Refining (Gaskell)	1804

Colorado School of Mines

Metal Sulfide Vaporization (Hager, Martins, Natalie)	0851
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Ohio State University

Electrochemical Factors in Fused-Salt-Enhanced Reduction (St. Pierre and Rapp)	3901
Mechanisms of Attack and Protection of Refractories (St. Pierre, Semler, Rapp)	3902

Massachusetts Institute of Technology

High Temperature Gas-Particle Reactions (Elliott & Spitzer)	2551
Behavior of Oxygen and Sulfur in Complex Mattes (Elliott)	2552
Plasma Particle Reaction Experiments (King)	2553

University of Minnesota

Chromium from Low-grade Concentrates in Transferred-Arc Plasma Furnace (Reid and Moore)	2751
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Utah - Generic Mineral Technology Center Profile
September 1, 1982 - June 30, 1984

Director John A. Herbst
 Comminution Center
 Mining and Mineral Resources Research
 University of Utah
 Salt Lake City, Ut. 84112

Activities (average number per year):

Research projects	16
Faculty support	13
Graduate student support	17

Total value of equipment purchased: \$362,117

Industrial support for scholarships,
fellowships and assistantships: \$ 18,150

Industrial Impacts:

1. Optimal control strategies for ball mill grinding:

A computer control strategy for milling circuits is being developed. The strategy will be incorporated in a general computer control executive software, which then can be transported to an industrial site for direct use. Such a strategy has been shown to increase milling throughput by 15-20 percent.

2. Two stage versus single stage classification:

In current practice part of the inefficiency in mineral processing plants is due to the inefficiency of the hydrocyclones. In this study the impact of two stage classification has been carefully evaluated. A scheme of classification by which milling efficiency can be significantly increased has been determined.

3. Mineral Liberation Analysis:

More often than not, an ore is ground too fine in current operations resulting in an overexpenditure of energy, but not necessarily an increase in valuable mineral recovery. A fast and accurate method of mineral liberation using IBAS-II image analyser has been developed. Industry can use this methodology to analyze mill product and save on energy by adjusting the particle size setpoint hourly or even more frequently.

<u>Project</u>	Utah Program	<u>Laboratory</u>
Adaptive Control of Rod-Ball Mills		Control
Application of Modern Control Theory to Crushing		Control
Breakage Mechanisms in Tumbling Mills		Fragmentation
Computer Simulation of Complex Comminution Circuits		Computational
Interaction of Particles During Fragmentation		Fragmentation
Large Grinding Mill Dynamics and Scale-up		Large Mills
Measurement and Prediction of Mineral Liberation		Characterization
Numerical Simulation of Comminution Processes in Jointed Geologic Media		Fragmentation
On-Line Estimation of Ball & Liner Wear in Tumbling Mills		Wear
Phenomenological Modeling of the Hydrocyclone		Classification
A Study of Basic Mechanisms of Corrosion Phenomena in Relation to Grinding Media		Wear
Study of Fluid-Flow Pattern and Particle Trajectories in the Hydrocyclone Using a High-Speed Motion		Fluid Flow
Tracer Study of Grind Rates and Transport in a Rod Mill		Tracer
Fine Grinding in a Stirred Ball Mill		General
Models for the Scale-up and Control of Conventional Tumbling Mills		General
Semi-autogenous Grinding Study		General

Affiliates Program

<u>Institution</u>	<u>Title</u>
University of Minnesota	The Role of Abrasion and Corrosion in Grinding Media Wear The Effect of Electrochemical Interactions and Alloy Composition on Grinding Media Wear and Subsequent Flotation Recovery
University of California at Berkeley	Grinding Aids and Transport in Comminution
The New Mexico Institute of Mining & Technology	The Comminution of Mineral Mixtures Explosively-induced Shock Waves in Ore Minerals: Fracture and Attenuation: Phase I and II
Colorado School of Mines	Energy of Fragmentation and Comminution in Percussive Drilling Semi-Autogenous Grinding
Michigan Technological University	Studies Relating to On-Line Line Measurement of Particle Size in Wet Grinding Circuit Feasibility Studies for On-Line Measurement of Solids Specific Gravity

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Dr. CROWLEY. We've been operating long distance from Reno to the Land Grant Association staff in Washington and both the 5-year report and the update of the last two years should have been submitted and I'm sure will be shortly submitted for the record, Mr. Chairman.

I would like to say in conclusion that the mineral institutes programs are well worth continuing. It's a modest investment in a very critical area which has already produced significant results and those results certainly have the potential to become even more significant in the future. It is a partnership of which we have heard a good deal about in recent years and which we believe in between the Federal Government, the State government, universities, and private industry. We don't think that any component of that partnership can be removed and the partnership will continue. That is not likely to happen if this support is not forthcoming for the mineral institute program. We do not believe that the slack will be picked up by the State and by industry. Dr. Strauss has already indicated what the industry position might be there. We believe the partnership would disappear and the institute program would disappear absent a continuation of the appropriation and support of that program.

Mr. Chairman, that concludes my testimony.

[The prepared statement of Dr. Crowley follows:]

Testimony of
 Dr. Joseph N. Crowley, President
 University of Nevada - Reno
 and
 Dr. J. Read Holland, Director
 School of Mines and Energy Development
 The University of Alabama
 for the
 Mineral Resources Committee
 of the
 National Association of State Universities
 and Land Grant Colleges
 before the
 House of Representatives Committee
 on Science and Technology
 Subcommittee on Aviation, Transportation, and Materials
 April 24, 1985

The State Mineral Institutes have become a vital element in research and development for the minerals community and in providing trained manpower for the mineral industries. Given that minerals are the front end of the materials cycle, it is appropriate to examine the State Mineral Institutes program within the context of the National Critical Materials Act of 1984.

In reviewing the draft report of the Congressional Workshop on Advanced Materials R&D, the great concern of the attendees about material processing is evident. One of the strengths of the State Mineral Institutes is that they are well versed in mineral processing. Mineral processing may be viewed as a mineral analogue of material processing. Advanced development of the science and technology of mineral processing are essential activities if this country is to utilize domestic mineral resources. These mineral resources are generally complex low grade ores that require sophisticated processing for economic recovery of the inherent mineral values. The maintenance of a healthy domestic mineral industry is dependent on continued advances in mineral processing. If such advances do not occur, then increasing dependence on foreign mineral sources will result. Such dependence is hazardous in terms of both national security and the health of the economy. Congressional concern over this issue of import dependence and deterioration of minerals and materials industries was clearly expressed in the National Critical Materials Act of 1984.

In our view, two activities of the Bureau of Mines in Minerals and Materials Research and the State Mineral Institutes are of paramount importance to the establishment of a national federal program for advanced materials research and technology. In view of recent Congressional actions to pass the National Critical Materials Act and to reauthorize the State Mineral Institutes (PL 98-409), these two activities merit vigorous support. It is difficult to reconcile the Department of Interior budget request of a harsh reduction (28%) in Minerals and Materials Research and

no appropriation for the State Mineral Institutes with the national need. Restoration of Minerals and Materials Research in the Bureau to the 1985 level is urged as is a minimum \$12,500,000 appropriation for the State Mineral Institutes. Since Congress intends to implement a national federal program for advanced materials research and technology, funding the State Mineral Institutes at the authorization level (\$24.4 million) is one step that should be given serious consideration. Such an increase allocated to the Institutes for the express purpose of advancing the mineral processing of non-fuel minerals would be a welcome boost to university research and training in an area that suffers from chronic underfunding.

Now we want to focus on the State Mineral Institutes. First we want to review the need for an appropriation, second I will review the Institute program briefly, and third we will give you a brief account of program accomplishments.

Appropriation Need

The State Mining and Mineral Resources Research Institutes were given resounding support by the 98th Congress when a revised program was reauthorized last year through PL 98-409. This mandate from Congress explicitly recognizes the national need for a viable domestic mineral industry. We agree with the recommendations of the Subcommittee on Mining and Natural Resources that the Mineral Institutes need to be supported at the level authorized in PL 98-409, \$24,400,000. Although we regard this as an optimal level, we recognize the harsh realities of budgetary constraints and the federal deficit. Our recommendation to the Appropriations Subcommittee then is a minimum of \$12,500,000 for the Mineral Institutes. This represents a current services budget based on the 1984 Mineral Institute appropriation with additional funding to support The Generic Center for Respirable Dust created by Congress in 1983. We recommend that this total be allocated as follows: (1) \$5,500,000 for allotment grants to the institutes and for program administration, and (b) \$7,000,000 for research grants.

The Mineral Institute Program

The Mineral Institute program is operated through 31 state institutes. The program has two nearly equal efforts -- 1) institution support, and 2) designated generic research programs. Each of the institutes receives an equal amount of allotment grant funds, which are subject to state matching requirements. The institutes use these funds to conduct state determined research programs and to provide student support.

The generic research programs are operated through five generic mineral technology centers which are located at State Mineral Institutes. Each center has a lead university (two in one case) with three to six additional institutes working as research affiliates. Thus the system is fully interactive and cooperative in organization and operation. The generic research areas, the generic center locations, and the center affiliates are:

<u>GENERIC AREA</u>	<u>CENTER</u>	<u>AFFILIATES</u>
Mine Systems Design and Ground Control	Virginia Polytechnic Institute & State University	University of Alabama University of Alaska - Fairbanks University of Idaho University of Kentucky University of Nevada - Reno
Comminution	University of Utah	University of Minnesota University of California Colorado School of Mines Michigan Tech New Mexico Tech
Mineral Industry Waste Treatment and Recovery	University of Nevada - Reno	University of Idaho Iowa State University Montana College of Mineral Science and Technology New Mexico Tech
Pyrometallurgy	University of Missouri - Rolla	Purdue Ohio State University Massachusetts Institute of Technology
Respirable Dust	Pennsylvania State University and West Virginia University	University of Minnesota Massachusetts Institute of Technology

Program Achievements

A five year record of achievements of the Mineral Institutes program was assembled last year to provide evidence for the reauthorization hearings and is submitted as appendix I to this testimony. Compared to the situation prior to the program (before September 1978) those achievements include support for over 200 research projects each year which have led to impacts such as the following: 1) research in the institutes at Illinois and Alabama has led to economically and environmentally acceptable processes for the recovery of energy from coal waste fines. Commercial applications have already been initiated; 2) four regions with high potential for the deep recovery of lignite have been identified by the Texas institute; 3) research into size reduction and liberation at the Pennsylvania institute has led to a major technological process innovation of importance to the ceramic and refractory industries. Attached as appendix II is an update to the record of achievements. A major development in this period has been to focus research into five disciplinary areas through the generic centers identified above.

All of the centers have attained significant accomplishments in a relatively short time. As an example these important findings have emerged from the respirable dust program: 1) there is a strong statistical correlation between certain chemical and physical properties of coal and the incidence of black lung disease; 2) freshly produced dust has significantly different chemical characteristics from aged dust (a finding that affects both physiological research programs and mine dust control strategies); 3) new instrumentation has enabled earlier identification of the onset of black lung disease, thereby permitting earlier rotation of mine workers to different jobs. The program has also significantly increased the quality and quantity of graduates in advanced mineral technology fields. This is a critical contribution to the development of human capital and future leadership in minerals production research and development. Mineral engineering and science graduates are obtaining important jobs in the mining and mineral processing industries. Employment opportunities are improving in the non-metallic industries which are healthy and progressing. In addition to non-metallic industries, fossil fuels, predominantly coal, will require new technology for efficient material handling, recovery, and upgrading for industrial use.

Mr. REID. Thank you, Dr. Crowley. Would you or Dr. Holland respond to this question? You know, if we as part of our national security goal buy an airplane, you can see that airplane. We buy a rifle and you can see that rifle. However, it makes it much more difficult to understand how this mineral research has any bearing whatsoever on our national security. In effect, the question I'm asking you two gentlemen is what difference does it make that we have this research going on?

Dr. CROWLEY. It seems that is we are going to develop the domestic minerals industry, it can only occur through increasingly more sophisticated research. If we don't do that, we're not going to develop the industry and we are going to become more dependent obviously on foreign mineral sources. That, it seems to me, is not healthy for the country and it would have a direct bearing on national security since we are not in a position very adequately to control those foreign sources.

Dr. HOLLAND. In the area of the mineral institutes, the Mineral Industry Program impinges on almost all the activities within the minerals community. It's very heavily focused on mineral processing but it deals with all of our mineral resources including those for agriculture, those for building materials, the nonfuel minerals, and the fuel minerals. Being focused as heavily as it is in many areas on mineral processing, that gives you—if you can advance the state of the art of mineral processing—we can return to use of our lower grade domestic ores, have short supplies of some critical materials that we would not otherwise have, and have the processing and technology in hand to use those ores.

It's hard to demonstrate just into specific or discreet examples how that's going to occur. Certainly the processing that has occurred are leading us to cleaner forms of coal for our coal-fired stations, for use of many of our domestic materials.

Mr. REID. Thank you very much. Mr. Lewis?

Mr. LEWIS. I have no questions at this time, Mr. Chairman.

Mr. REID. Mr. Packard? I thought Ron was here. I have a couple of questions. Dr. Crowley, does our university have other minerals research programs? University of Nevada?

Dr. CROWLEY. Yes, we have been, of course, active in research in minerals for a long time.

Mr. REID. What impact would the deletion of this program have on the university?

Dr. CROWLEY. Well, Mr. Chairman, the Mackie School of Mines, as you know, has a long history and a prestigious history. Although it had been sliding a bit in the decade of the seventies, it has undergone a resurgence in the period since then. There are a lot of reasons for that and I would not wish to say that the establishment of the minerals institutes program was the principal reason, but it certainly was a significant reason. It focused the attention of the industry on the university and the school of mines. It helped to attract faculty to the program in an area where faculty are difficult to attract. It helped bring back students to the program. Our student population has been growing these last 5 years, although prior to that it was in a state of serious decline.

The attention of the State is still focused on the school. It's well thought of. However, it certainly would not be in the position that it now enjoys and it does enjoy a considerable position. It is one of the very few centers of excellence that the university has designated for increased support. It would not enjoy that position absent the kind of investment that the mineral institutes program has made possible. Again, that's a modest investment but we're getting a lot out of that investment.

Mr. REID. Dr. Crowley, I specifically mentioned the University of Nevada at Reno. I think your statement could apply to most universities, don't you believe so, that this program is an essential part of the university research program.

Dr. CROWLEY. I certainly do. It's a leverage program. It produces results far in excess of the modest investment that is suggested.

Mr. REID. Mr. Lewis?

Mr. LEWIS. Thank you, Mr. Chairman. Dr. Crowley, should the Federal Government supply funding for students in minerals and mining technology? You more or less just pointed out that you didn't have any lack of students in that area.

Dr. CROWLEY. What I was pointing out was that for a number of reasons our enrollment in the school of mines, which is a relatively small school, has been growing in recent years, although it seems to have stabilized this year.

Mr. LEWIS. Is this significant of most mining schools?

Dr. CROWLEY. I think Dr. Holland could probably better answer than I, but it's my impression that that by and large is a national trend.

Mr. REID. Dr. Crowley, didn't you also say that you've attracted better students and better faculty because of this program?

Dr. CROWLEY. I think the quality of the students has improved. We were losing a number of students to other institutions in Western States: to Idaho; to Montana Tech; to Colorado School of Mines; University of Arizona. The quality of our program had declined.

Mr. REID. Weren't they also going into different disciplines?

Dr. CROWLEY. Of course, they were. The support available through the institute program, which in a small institution in a small school makes a major difference, we think has been a critical

factor in attracting a better quality of student both at the undergraduate level and graduate students to the school of mines.

Mr. LEWIS. So, you feel there is a need for Federal assistance?

Dr. CROWLEY. Indeed we do, sir.

Mr. REID. Dr. Holland.

Dr. HOLLAND. In response to your question, Mr. Lewis, the support really derives from the research support that comes out of the MMRRI funds. For example, we get the students involved in the research activities. They are compensated in some degree for that. Being involved in those research projects, they get the training that they would not have otherwise gotten that enhances their educational program. It's not a direct support for the students but it's a derivative of the program, and a very important one.

Dr. CROWLEY. That indirect support helps to produce scholarship contributions by industry as part of the partnership. They provide donations to the scholarship program which do directly support students in the program.

Mr. LEWIS. Thank you.

Mr. REID. Yes, Mr. Lewis. Dr. Holland, did you want to add something before we close?

Dr. HOLLAND. In your earlier question to Dr. Crowley about how the support is used and what additional benefits it has, let me just cite one example. At the University of Alabama, we view the support from the mineral institute program as a vital element of our overall mix for minerals research and energy research. I think because of the presence of that program, we were able to approach the board of trustees and get authorization for a building program for a \$10 million building energy and minerals research complex. That money—\$2.4 million—came from State sources; \$6.6 million came from university sources; and a million from private giving. If it weren't for the \$150,000 a year that the Federal Government is putting into the institute program, I doubt that that would have come about.

Mr. REID. Thank you, Dr. Holland. Dr. Crowley, we appreciate very much you being here.

Dr. CROWLEY. Thank you very much, Mr. Chairman.

Mr. REID. I'm sorry. Mr. Packard, did you have any questions?

Mr. PACKARD. I'm sorry I had to step out for a minute. I was wondering if you're seeing an increase of foreign students relative to mineral and mining engineering coming to your institutions?

Dr. CROWLEY. I think that would be fair to say, yes.

Mr. PACKARD. Under what arrangements do they come? Do they enter our schools under the same general financial arrangement as does our domestic students?

Dr. CROWLEY. In our case, Mr. Packard, those students would pay nonresident tuition—

Mr. PACKARD. Out of State?

Dr. CROWLEY. Yes, out of State tuition.

Mr. PACKARD. Just like someone coming from another State?

Dr. CROWLEY. That's correct. In most cases, the cost of their education is borne by the students themselves or their families or the governments of the country from which they come.

Mr. PACKARD. From what information you have, the institutions themselves or our Government is not subsidizing their education?

Dr. CROWLEY. No, I would not.

Mr. PACKARD. The foreign countries I have visited have indicated an improvement of their technology, their ability to compete. I particularly think of Korea and Taiwan and some of those countries are now becoming major competitors for our own mineral industries. They've become quite competent. I'm aware that we're training many of their engineers and their scientists here and I was wondering if, in fact, this is a form of subsidy from our Government to theirs.

Dr. CROWLEY. Perhaps Dr. Holland would care to comment on that as director of a school.

Dr. HOLLAND. There has been an increase but it's the same increase you're seeing in engineering and science. In our institution, they come as they do at the University of Nevada. They come as an out of State resident and they pay the full burden. Some of them do get involved in our research activities, particularly at the graduate level. They are involved. We do not distinguish between them and any other student that we have there.

Mr. REID. This is a subject of another hearing, of course, but that's one of the things that another committee that I serve on we've been trying to do to stimulate from some of the developing countries to come here and be educated. That's one of the reasons we're losing to the Soviet bloc nations because they're importing all these students and indoctrinating them in other principles other than just straight education.

We should be educating, in my opinion, a lot more foreign students than we are.

Thank you very much, gentlemen, for your testimony. It was most rewarding to us.

Out last witness of the hearings this morning is Mr. Richard M. Cooperman of the Aluminum Recycling Association. Mr. Cooperman, we appreciate your patience in waiting for us this morning. You're living here in Washington and I'm sure you've been through this before and understand.

STATEMENT OF RICHARD M. COOPERMAN, ALUMINUM RECYCLING ASSOCIATION, WASHINGTON, DC

Mr. COOPERMAN. I appreciate the invitation to testify.

Mr. REID. I would ask that you not read your statement but outline it for us verbally so we can have an opportunity to exchange some ideas with you.

Mr. COOPERMAN. Thank you, Mr. Chairman. I really want to highlight just two or three points in the testimony since you have it before you. First of all, aluminum recycling in this country is an old industry. It's about to reach its 80th year. It predates the business of recycling cans by many years. It is sometimes confused with recycling cans. It provides about 25 percent of this country's annual aluminum requirement.

Mr. REID. Mr. Cooperman, your full statement will be made part of the record, as I have indicated to the other witnesses.

Mr. COOPERMAN. Thank you, Mr. Chairman.

There are 53 nonintegrated companies around the country and they operate about 65 plants. Many of these companies are family

founded, family owned. Some of them are divisions of major corporations. I want to make a point that I think is useful in your deliberation. First I want to associate myself with Dr. Strauss' point that the loss of an ability to do research in the Bureau is critical not only to the mining industry but the materials aspect of it, too.

Our companies produce specification ingot. That means it is a special alloy to meet the specific demands of the automobile industry, the construction industry, and many other industries. Some of you will find that you have aluminum pistons in your cars; aluminum engine blocks in your cars; aluminum manifolds in your cars. The computer and electronics industry also has specification aluminum ingot in it that is put into a usable form in castings.

One of the things that I think we are concerned about is the ability of the United States to develop new alloys for the applications which we see all around this room. While we are not in a position to particularly enter into new alloy applications with the Bureau of Mines, the Aluminum Recycling Association in conjunction with zinc alloyers and one of the major aerospace companies in the country, has recently met with NASA to look at the possibility of testing alloying processes in a nonterrestrial atmosphere. Specifically, they want to test the process of alloying on one of the Shuttle flights.

I think that, in a sense, we haven't exhausted all the possibilities of developing new alloys on the ground. That's part of our problem with the Bureau of Mines. We would like to see them in a position to be able to participate with us in this sort of activity and get some things done here on earth before we have to go off into space to do it, although we're certain the space experience will be valuable to us.

I think the final point I would make is that, unlike the mining industry, we have an endless supply of raw materials in the United States. Scrap aluminum is about 85 percent of the out-the-door price of our ingot. As long as aluminum is being used in this country, whether the primary aluminum or the alumina or the bauxite is produced in this country, there will be scrap and we will continue to be able to produce secondary aluminum.

The possibility of our running out of scrap is virtually nil unless the total aluminum industry shuts down. Primary aluminum companies today engage in the use of aluminum scrap in order to get back into the system the aluminum metal units that they've lost by not producing and also by shutting down primary production facilities in the United States.

The secondary aluminum industry uses about 45 percent of the scrap generated in the United States. Another 40 to 45 percent is used by the primary industry. Both industries are today being subject to a rather intensive import of both primary and secondary ingot. We will not have the same problems that the American mining industry does, but we will be faced with problems in production and sale of products made out of secondary aluminum and, in this case, instead of shutting down operations, we will simply be backing up the inevitable production of scrap. We will find ourselves with increasing amounts of scrap in the United States simply because imports of secondary aluminum are not using all of the scrap that we would be using ourselves.

You return to a reversal of a system which has worked very well to generate scrap to reuse it in secondary aluminum. If you do reverse that system by not paying attention to the same kind of problem that the U.S. mining industry has had, we will face some disruption of the secondary aluminum industry, too.

I think, gentlemen, with that comment I would stop my observations and give you an opportunity to question.

[The prepared statement of Mr. Cooperman follows:]

TESTIMONY OF
ALUMINUM RECYCLING ASSOCIATION
BEFORE
THE SUBCOMMITTEE ON TRANSPORTATION,
AVIATION AND MATERIALS
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

MR. CHAIRMAN, MEMBERS OF THE COMMITTEE, MY NAME IS RICHARD M. COOPERMAN. I AM THE EXECUTIVE DIRECTOR OF THE ALUMINUM RECYCLING ASSOCIATION, WITH OFFICES HERE IN WASHINGTON, DC.

JUST BY WAY OF BACKGROUND, THE SECONDARY ALUMINUM INDUSTRY TO PRODUCE SPECIFICATION ALUMINUM INGOT FOR CASTING AND METAL MARKETS WAS BEGUN IN 1908 BY TWO COMPANIES THAT ARE STILL IN EXISTENCE. OVER THE TIME OF ITS HISTORY, THE INDUSTRY HAS RECYCLED ABOUT 54 BILLION POUNDS OF ALUMINUM SCRAP FROM INDUSTRIAL AND POST-CONSUMER WASTES. WE RECYCLE VERY, VERY FEW USED BEVERAGE CONTAINERS. THEIR CHEMISTRY IS NOT CONDUCTIVE TO PRODUCING THE SPECIFICATION INGOT OUR CUSTOMERS REQUIRE.

THE ALUMINUM RECYCLING ASSOCIATION WAS BEGUN IN 1929. IT HAS ALWAYS REPRESENTED THE SECONDARY ALUMINUM SMELTERS IN THE UNITED STATES. THERE ARE 53 SUCH COMPANIES THAT OPERATE 66 PLANTS RANGING IN SIZE FROM SMALL FAMILY OPERATED COMPANIES TO MULTI-PLANT DIVISIONS OF SOME OF THIS NATION'S LARGEST COMPANIES

APPENDED TO THIS STATEMENT IS A LIST OF NON-INTEGRATED SECONDARY SMELTERS IN THE UNITED STATES.

RECYCLERS ARE ENGAGED IN PRODUCING SPECIFICATION MATERIALS; IN MARKETING THEIR PRODUCT; IN FINANCING THEIR OPERATIONS; IN DISTRIBUTING THEIR PRODUCTS; IN SERVING THE PUBLIC AND IN TRYING TO GAIN A RETURN ON THEIR INVESTMENTS.

THE INDUSTRY HAS A CAPACITY OF 2.31 BILLION POUNDS PER YEAR; LAST YEAR'S TOTAL SHIPMENTS WAS 1.76 BILLION POUNDS.

THE INDUSTRY IS CAPITAL-INTENSIVE, HIGHLY COMPETITIVE AND IS ABOUT A BILLION-DOLLAR-A-YEAR INDUSTRY.

IT PROVIDES THIS COUNTRY WITH APPROXIMATELY 25 PERCENT OF THE ALUMINUM CONSUMED ANNUALLY.

IN THE SIMPLEST TERMS, OUR COMPANIES BUY A VARIETY OF ALUMINUM BASE SCRAPS, MELT THEM AND DETERMINE THEIR CHEMISTRY, ADD ALLOYING MATERIALS TO PRODUCE THE SPECIFICATIONS REQUIRED, AND POUR THE ALLOY INTO INGOT MOLDS FOR DELIVERY. THERE ARE MANY ALLOYS PRODUCED AND SOLD IN THE MARKETPLACE. THE SCIENCE OF PRODUCING ALUMINUM INGOT FROM SCRAP HAS GROWN ENORMOUSLY FROM THE FIRST DECADE OF THIS CENTURY TO THE PRESENT.

OVER THE YEARS, BETWEEN FIVE AND TEN INDIVIDUAL COMPANIES HAVE EITHER AVAILED THEMSELVES OF THE RESOURCES OF THE BUREAU OF MINES OR BEEN A PART OF RESEARCH OR SCIENTIFIC PROJECTS AFFECTING THE SECONDARY ALUMINUM INDUSTRY. MOST RECENTLY, IN 1981, THE ARA HAD A COOPERATIVE AGREEMENT WITH THE BUREAU FOR STUDIES IN THE FIELD OF FLUXLESS FURNACE OPERATIONS. THE AGREEMENT ESSENTIALLY WAS FOR THE EXCHANGE OF INFORMATION AND SEVERAL OF OUR COMPANIES CONTRIBUTED ALUMINUM SCRAP TO THE BUREAU'S LABORATORIES.

I CANNOT SAY THE EXPERIENCE WAS ESPECIALLY FRUITFUL SINCE WE DO NOT KNOW THE FINAL OUTCOME OF THE BUREAU'S WORK.

IN 1981 AND 1982 THE BUREAU, IN COOPERATION WITH MIT AND WITH THE SUPPORT OF ARA AND MANY OTHER ASSOCIATIONS REPRESENTING THE INDUSTRY, SOUGHT TO DEVELOP AN "ALUMINUM RECYCLING TECHNOLOGY CONFERENCE." THIS WOULD HAVE BEEN A VERY CONSTRUCTIVE PROGRAM

FOR ALUMINUM RECYCLING, AND THE BUREAU HAS TO BE COMMENDED FOR ITS UNDERTAKING. UNFORTUNATELY, INDUSTRY ECONOMICS AT THE TIME THE CONFERENCE WAS TO BE HELD, PROHIBITED ITS IMPLEMENTATION. FOR THE COMMITTEE'S INFORMATION, I SUBMIT THE DRAFT OF THE BROCHURE INTENDED TO PUBLICIZE THE EVENT.

FINALLY, INDIVIDUAL SECONDARY ALUMINUM COMPANIES OVER THE YEARS HAVE PARTICIPATED IN THE BUREAU'S STATISTICAL PROGRAMS. LAST YEAR, WHEN THE BUREAU UNDERTOOK TO REVISE A FORM FOR GATHERING ALUMINUM SCRAP INFORMATION, ONE OF THE MAJOR COMPANIES IN THE INDUSTRY RESPONDED, AND THE ASSOCIATION LET THAT RESPONSE STAND FOR THE INDUSTRY.

IT WOULD BE VERY HELPFUL TO OUR INDUSTRY, AND ALL INDUSTRIES IF THE BUREAU WERE TO HAVE THE FUNDING AND THE CAPABILITY OF MORE RAPID TURNAROUND FROM COLLECTION TO PUBLICATION OF ITS STATISTICS.

THE UNITED STATES HAS BECOME FOREIGN-SOURCE DEPENDENT FOR MANY, MANY MINERAL RESOURCE MATERIALS. THE TIME HAS COME TO RECOGNIZE THAT SCRAP MATERIALS LIKE THE ALUMINUM BASED SCRAP FROM WHICH OUR INDUSTRY PRODUCES SPECIFICATION INGOT, MAY BE THE REMAINING RESOURCE FOR WHICH THE UNITED STATES IS DEPENDENT UPON NO ONE.

GIVEN THAT CIRCUMSTANCE; GIVEN THE CIRCUMSTANCE OF THE ENERGY AND RAW MATERIALS PRESERVATION INHERENT IN ALUMINUM RECYCLING, IT IS TIME THAT A NATIONAL CONFERENCE IS CALLED, UNDER THE AEGIS OF THE DEPARTMENT OF INTERIOR TO AUDIT AND ASSESS THE RECYCLING OF ALL NONFERROUS METALS; THEIR IMPACT UPON OUR COLLECTION SYSTEMS; OUR DATA BASES AND OUR DISTRIBUTION SYSTEMS.

Mr. REID. Thank you very much. Mr. Cooperman, just from a nonscientific standpoint, I think I was surprised at how old your industry is. Second, your statement that you recycle very few used beverage containers. We all think that you take a Coors beer can and make a Pabst beer can out of it or something but that isn't the case.

Mr. COOPERMAN. Mr. Chairman, the chemistry of used beer cans is such that it just cannot support the——

Mr. REID. What do you do with them?

Mr. COOPERMAN. They are all recycled by other companies and they return them to can sheet stock for making new cans.

Mr. REID. What you're saying is you can't reuse the beer can. It has to be processed all over again.

Mr. COOPERMAN. Yes, and it really only can be processed back into can sheet stock for the production of other cans.

Mr. REID. I misunderstood that. I understand now. What will be the effect of the proposed budget cuts within the Bureau of Mines on recycling? You've answered that in a general term but tell us more specifically.

Mr. COOPERMAN. I don't think I have a specific answer for you, Mr. Chairman. Recycling is going to continue regardless of the budget cuts. When the budget cuts affect the institution of the Bureau of Mines and affect its ability to participate within industry in the kind of research that we need, in effect we go elsewhere and that's what we're doing when we talk to NASA. We'd like to be able to continue to operate with the Bureau of Mines. We haven't been involved with the bureau since 1981 as my testimony indicates. We'd like to be able to do it on a more frequent level and on an application specific basis. If the secondary aluminum industry in this country is going to expand to be able to produce and market to its capacity—you can see from the testimony that our consumption last year was something like 22 percent below production capacity—if we're going to be able to use all of our capacity, we need to be in research to develop new applications and to improve our processes.

The 1981 work with the Bureau was an attempt to improve our processes and we still don't know the results. That's not a failing of the Bureau. They really weren't able to complete all the work——

Mr. REID. Because of the budget considerations.

Mr. COOPERMAN. Yes, sir.

Mr. REID. It would seem to me that many of the things that you're engaged in are used more in the United States than other places. We have more pop cans, more beer cans, more containers than most other countries. Is that true?

Mr. COOPERMAN. No, West Germany, the U.K., France, and Japan use enormous amounts of recycled aluminum in the same applications we do.

Mr. REID. Do they recycle their own?

Mr. COOPERMAN. The Japanese come to this country to buy very sizable amounts of scrap.

Mr. REID. We are a net exporter of scrap aluminum?

Mr. COOPERMAN. No, sir, we use most of our scrap. If I may just take one moment of your time.

Mr. REID. Please do.

Mr. COOPERMAN. We are in this position. We have to buy scrap in order to make our product. Scrap prices are very volatile and they are easily susceptible of large amounts of exports from the United States. Not infrequently, the Japanese, particularly, will come into the west coast, buy very sizable amounts of scrap when the price is low or lowering, and they watch the market very carefully, they take that scrap out of the United States. It has three effects. One, it automatically raises the price of scrap in the United States. Two, it comes back into the United States in the form of parts incorporated in Japanese automobiles. Three, it has a worldwide effect in this sense. When the price of scrap goes up, the price of our ingot should go up to follow it because scrap is such a large part of the cost of our ingot. At the same time that the Japanese, in January and February of this year, took a good deal of scrap out of the United States and raised the price of scrap, the U.K. and other EC countries were selling ingot in this country in competition with our ingot at very low prices. This brought the price of secondary ingot down.

We find ourselves in a squeeze in an international market. Our raw material leaves the country, increases the price of our raw material, we suffer an influx of cheaper ingot from the European countries and that brings down the price of our ingot. We're in a squeeze between the two.

It has an effect which ought to be studied by the Bureau.

Mr. REID. I appreciate that comment. Mr. Lewis?

Mr. LEWIS. Thank you, Mr. Chairman. You stated in your testimony that the recycling industry has been operating since 1908. How long has the Federal Government been involved in recycling research?

Mr. COOPERMAN. Congressman Lewis, while I do not have fully detailed knowledge of Government's involvement in recycling research, individual member companies of the ARA have worked with the Bureau on various research projects. The ARA, although it had been involved directly with the Bureau only since 1981, is aware that the Bureau's research projects in recycling have been pursued actively and fruitfully over the past three decades.

Mr. LEWIS. To your knowledge, there is no impact on the recycling industry by the Government as far as research?

Mr. COOPERMAN. Generally, no.

Mr. LEWIS. Thank you, Mr. Chairman.

Mr. REID. As indicated, Mr. Cooperman, your concern was the overall minerals industry in the country rather than your specific industry?

Mr. COOPERMAN. Not completely, Congressman Reid. As it affects the overall mining and mineral industry, it also affects the materials industry. A reduction in the ability of the Bureau of Mines to work with industry has an adverse effect upon our ability to develop new processes, our ability to develop new alloys and new applications in the industry.

[See letter that follows:]



**ALUMINUM
RECYCLING
ASSOCIATION**

900 17th Street, N.W.
Suite 504
Washington, D.C. 20006

May 11, 1985

Note: The new telephone
numbers are
202/785-0951 and
785-0952

Mr. Winifred Mathis
Subcommittee on Transportation,
Aviation, and Materials
2321 Rayburn House Office Bldg.
Washington, D.C. 20515

Dear Mr. Mathis:

I return herewith the transcript of my testimony of April 24, 1985 before the Subcommittee.

My corrections are minor.

If possible, I would like to amend my testimony. At page 67, Congressman Lewis asked "How long has the Federal Government been involved in recycling research?"

I did not hear the word "research", and I took Congressman Lewis' question to mean Federal Government involvement other than research. Had I realized the full significance of the question, I would have responded differently so that my remarks at page 67, lines 1515 to 1557 and at 1560 could well have read:

"Congressman Lewis, while I do not have fully detailed knowledge of the Government's involvement in recycling research, individual member companies of the ARA have worked with the Bureau on various research projects. The ARA, although it had been involved directly with the Bureau only since 1981, is aware that the Bureau's research projects in recycling have been pursued actively and fruitfully over the past three decades.

May I ask that this matter be placed before Chairman Dan Glickman and that it, together with my explanation, be considered a written appeal to the Chairman to permit amendment of the testimony.

Thank you for your attention.

Very truly yours,

R. M. Cooperman

Enclosure

RMC:br

Mr. REID. Thank you. On behalf of the chairman of the committee, Dan Glickman, I appreciate the testimony today of Mr. Horton, Dr. Strauss, Mr. Cooperman, Dr. Crowley, and Dr. Holland. We appreciate it very much.

At this time, the committee stands in adjournment.

[Whereupon, at 11:20 a.m., the subcommittee recessed to reconvene at the call of the Chair.]

